UHASSELT

KNOWLEDGE IN ACTION

Faculty of Business Economics

Master of Management

Master's thesis

How the introduction of electric cars is disrupting the car industry?

Renaud Herman

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization International Marketing Strategy

SUPERVISOR :

Prof. dr. Wim VANHAVERBEKE

2018
2019

UHASSELT

KNOWLEDGE IN ACTION

www.uhasselt.be
Universiteit Hasselt
Campus Hasselt:
Martelarenlaan 42 | 3500 Hasselt
Campus Diepenbeek:
Agoralaan Gebouw D | 3590 Diepenbeek

UHASSELT

KNOWLEDGE IN ACTION

Faculty of Business Economics

Master of Management

Master's thesis

_How the introduction of electric cars is disrupting the car industry?

Renaud Herman

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization International Marketing Strategy

SUPERVISOR :

Prof. dr. Wim VANHAVERBEKE

Acknowledgements

First of all, I would like to thank my supervisor, Wim Vanhaverbeke, for all the feedbacks and advises he gave to me. He brought me strong support to refine my master thesis and to present a consistent and strong paper.

Moreover, I would like to thank some people for the time they spent to answer to my questions. I really appreciated to exchange points of view with them. It also brought me other ways of looking at the electric vehicle ecosystem.

- Galand Benoît: Journalist in the automotive industry for more than 20 years. In the past, he was chief writer and director for the magazine: Turbo Magazine
- Miserque Thibaut: Sales advisor for the brand Tesla. He is a member of the promotion campagne of Tesla in Belgium. He is also director of a young automobile website dedicated to car tests: Drive Time.
- Neve Laurence: Sales responsible and administration responsible for the Switzerland electric brand: Kyburz. She is managing and in charge of the project “eRod”.

Summary

The car industry concerns everybody across the world. It is one of the most developed industries, with many important actors involved. The car industry has been disrupted several times before; it is an industry where innovation is constantly changing the market. Recently, there has been growing interest in the electric car. Due to environmental concerns, the carbon resource crisis, and gasoline prices, it seems that the automobile market is ready to face the infiltration of electric vehicles (EVs). Additionally, advancements in technology, connectivity, and manufacturer involvement strengthen the value of the electric car in the industry.

As I have been passionate about cars since I was a child, I wanted to study this possible new wave of car manufacturing. This is why the main goal of this research paper is to study how the introduction of the electric cars will disrupt the car industry.

The first objective of this paper is to determine the ecosystem necessary for the success of EVs. This section demonstrates the importance of leveraging all actors in the ecosystem and increasing collaboration between members.

As cars manufacturers are the main actors of the industry, the second objective is to study how manufacturers must adapt their business model to promote the electric car introduction. If they want to follow the market, manufacturers must change part of their business model to remain competitive.

The last objective of this report concerns the government and how they can act as an engine to boost the expansion of electric cars. Some national governments are strongly committed to help the electric car introduction (such as Norway or Denmark). There are several ways to promote electric cars; the last chapter is divided between targeted examples to illustrate how the EV launch depends on public entities.

Table of figures

Introduction

"The transport sector is the largest source of greenhouse gas emissions in the industrialized world. This sector is responsible for 25% of C02 emissions in the European Union. Three fifths of which can be attributed to private automobiles." This sentence comes from a report by Alexander Kihm and Stefan Tommer (2014). It plainly demonstrates that a solution is required for the future of the planet and the car industry. In my opinion, electric cars are the best solution to resolve this emissions problem.

Many governments and car manufacturers share the same opinion and are strongly investing in the introduction of electric cars. They all want to see an increase in EVs on our roads. However, in a study from McKinsey (2017), a table attracted my attention:

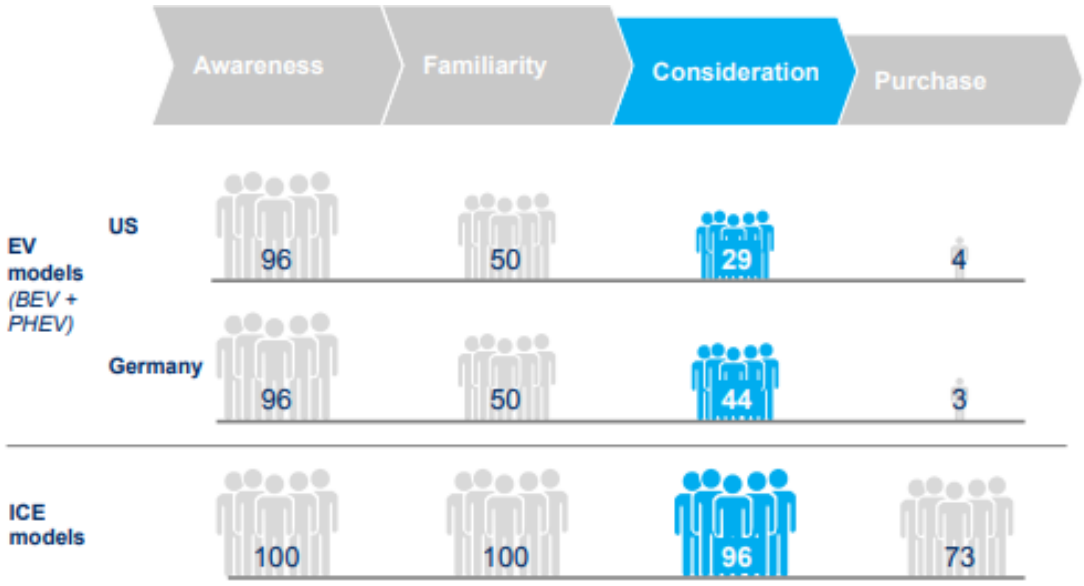


Figure 1: Percentage of consumers that identify themselves at each stage of the purchase cycle.
From the report *"How automakers can drive electrified vehicle sales and profitability", McKinsey and Company,* page 9.

This table demonstrates the difference in consumers' perceptions between the internal combustion engine (ICE) models and the EV models. The ICE model is the car ecosystem based on gasoline as the main energy for running our vehicles. We see particularly major differences in the consideration of EV and ICE models (29% or 44% versus 96%). Additionally, only 4% of

consumers decide to buy an EV. I was confused by this table. From a 96% in consumers' awareness, it falls to 4% for the final purchase. A question grew in my mind … why? Thus, I was motivated to investigate the electric world even further.

Even if electric cars will erupt, such is not yet the case. A possible reason is that the entire ecosystem is not ready to change its way of operating at the moment. This is why, we arrive at the main research question of this paper: how the introduction of electric cars is disrupting the industry? To answer this question, I have divided my paper into three main sections.

Chapter 1 provides an overview of the car industry. From a summary of the car industry history to its current situation, this chapter illuminates the boundaries of the car market. Subchapter 1.2 completes the chapter with a brief abstract of the electric car history and how an EV runs. In the final section of this chapter, we dive deeper into the subject by analyzing the various barriers against entry for the electric car.

In ***Chapter 2***, we enter the main body of this thesis by analyzing the ecosystem needed to introduce electric cars as mainstream transport vehicles. This chapter shows that ecosystem actors must change their behavior by enhancing collaboration among themselves instead of working separately. In Subchapter 2.2, we continue to study the ecosystem by examining the value blueprint, especially the co-innovation and adoption risks concerning electric cars. It means demonstrating how prepared members are to accept electric cars and collaborate to leverage the entire ecosystem. In Subchapter 2.3, we focus on how industry players must adapt their business models to follow the market and remain competitive over time. We can see that the electric car requires new skills and knowledge; the present business model cannot be used for this new wave of cars.

Finally, in ***Chapter 3***, we study how the government can be the engine behind the EV launch. This section is illustrated with examples of "good actors" to demonstrate how the government can increase its commitment.

Chapter 1: Car Industry

1.1) From yesterday to tomorrow

1.1.1) The car industry history

As stated by Alan K. Binder and John Bell Rae (1999), the automotive industry includes all companies and activities involved in the design, development, manufacturing, marketing, and selling of motor vehicles. For years, the automotive industry has faced revolution and disruptive innovation.

Georges Ageon (2007) described the beginning of automotive history: The first steam-powered automobile able to transport people was built by Cugnot in 1769. His vehicle was divided into two main parts: the cockpit and the boiler. The “Fire Truck” was boosted by a single drive wheel using two pistons, transmitting the energy provided by the steam boiler.

In 1870, Siegried Marcus designed the first gasoline powered engine. At that time, many inventors were continuously working on such technology, making several improvements. Nikolaus Otto improved gasoline technology by developing an ICE. Rudolf Diesel created a similar four-stroke diesel engine. Karl Benz developed a car that could be boosted by petrol or gasoline.

Further, the Ford Motor Company and its Ford Model T generated the greatest revolution in the car industry. Thanks to Ford, the automotive industry stepped forward; the Ford T was the first automobile to be mass-produced using moving assembling lines instead of individual hand crafting. Before 1927, approximately 15.000.000 models were produced.

After the Second World War, advancements in computers and electronics sparked a new change. Manufacturers focused on improving performance, comfort, features, and safety through electronic assistance. Cars became increasingly attractive while being boosted by the same gasoline engine concept.

From the beginning of the 21st century, a new wave of engine can be noted. There has been an increased interest in the electric engine. Even if this kind of motorization has faced failure

in the past, growing concerns over the environment have provided a new opportunity to this energy source. With higher gasoline prices, improvements in batteries, and the instability of gasoline providers, electric cars enjoy a renewed interest.

1.1.2) Types of powertrains

As we can read in the report "Electric vehicles in Europe: gearing up for a new phase?" from the Amsterdam Roundtable Foundation and McKinsey Company The Netherlands (2014), there are currently six main powertrains on our roads.

Internal Combustion Engine

Currently, ICEs represent the highest range of vehicles in the industry. These cars operate with only the usual combustion engine. There is no dependence on electric infrastructure, instead featuring a high fuel consumption, which means high exhaust emissions.

Hybrid Electric Vehicle

Hybrid Electric Vehicles (HEVs) are cars using combustion engine and/or e-motor. This powertrain is a hybrid configuration of an electric motor and an ICE. The ICE is the main provider of energy in the vehicle with the support of an included electric motor. The ICE train charges the small electric batteries. At low speed and for reduced distances, the electric motor can be used separately. These vehicles have a similar autonomy to ICE vehicles, but HEVs enjoy a better fuel economy.

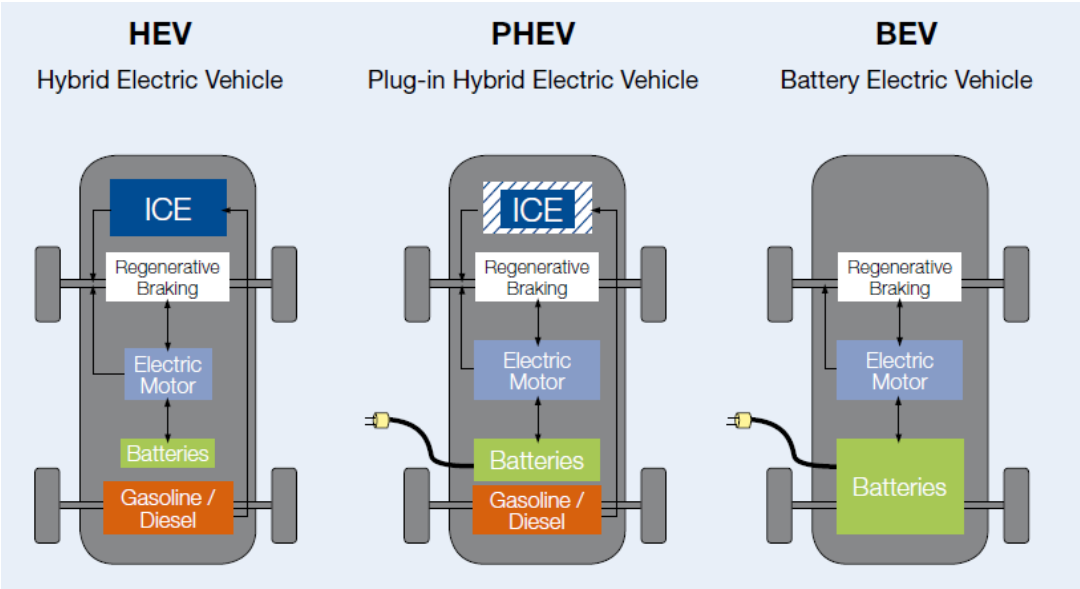


Figure 1.1: Engine overview of the different types of electric vehicle.
Picture from the article "Hybrid, PHEV, HEV, BEV: What does it all mean?"

Plug-in Hybrid Electric Vehicle

Plug-in Hybrid Electric Vehicles (PHEVs) are similar to HEVs. But instead of charging the small batteries with the ICE train while moving, they are charged through a plug-in system.

Range Extended Electric Vehicle

Range Extended Electric Vehicles (REEVs) are powered by an e-motor only. However, an ICE and plug-in system are used to recharge the batteries. There is a combination of electric and ICE drives. Small ICE-based generators are included to ensure greater autonomy than the Battery Electric Vehicle (BEV).

Battery Electric Vehicle

The BEV is a vehicle driven with only an e-motor and energy stored in the batteries. It is a fully electric system. It is only possible to charge batteries from the grid while stationary or via a system of regenerative braking (further explanation provided below). The BEV range of vehicles is not currently well developed, but we have seen significant involvement from manufacturers in such technologies.

Fuel Cell Electric Vehicle

Fuel Cell Electric Vehicles (FCEVs) are powered with only an e-motor and energy stored in hydrogen. These vehicles include a fuel cell system and electric drive. The hydrogen tank pressure is typically between 350 and 700 bars.

1.1.3) Current situation

Today's world is changing rapidly. Emerging markets, innovative technologies, government policies, digitalization, ownership preferences, etc., have started revolutions in many industries. In the automotive industry, McKinsey Company (2016) has explained how those forces provide power to four disruptive, technology-driven trends that can greatly impact the future of the industry.

The first trend is a shift in markets and revenue pools. Many people argue that the automotive industry is declining sharply. However, it is more appropriate to assert that the automotive industry is shifting toward other services and markets. Data connectivity and shared mobility

services are continuously growing, while the economy in emerging economies such as the BRICs (Brazil, Russia, India, and China) is totally booming. Despite a growth in car related services, vehicle unit sales are expected to continue to grow, just at a slower rate. The growth rate is expected to decline from 3.6% to 2.0% in 2030. This reduction is largely due to macroeconomic factors and the entry of new mobility services, such as car sharing. This observation confirms that revenues are shifting to other revenue pools.

Changes in mobility behavior represent **our second trend**. Today, consumers use their cars for various purposes. To go to work, on holiday, or out for a drink with friends - all these tasks use the same car. In the near future, it is expected that customers will require greater flexibility in choosing a car that best suits their needs, depending on the purpose of the mobility task. The increase in connectivity and communication reinforces this trend. Some visible elements can also confirm this change: private car ownership is dropping while shared mobility is increasing.

As the picture below shows us, customers will soon prefer to use different cars adapted to the activity they perform; but it is not possible to buy a car for each possible need. This is the main reason why new services in the automotive industry must arrive on the market. Due to increased connectivity, sharing, exchanging, or renting a car has become much easier than before.

Figure 1.2: How citizens will use their cars in 2030.
From the report*: The increasing complexity of the competitive landscape for individual mobility from automotive revolution – perspective towards 2030, McKinsey and Company*, page 8.

The third trend is the diffusion of advanced technology. From the beginning of the 21st century, we have seen a growing interest in autonomous and electric technologies. Autonomous vehicles (AVs) are expected to represent 15% of new cars sold in 2030. Before this advent, technological and regulatory issues must be resolved. We can already see the first challenges AVs will face: pricing, consumer understanding, and safety issues.

At the same time, EVs profit from a new, stronger opportunity for market penetration. The adoption relies upon the interaction between the consumers' total cost of ownership and regulatory incentives. We can expect sales of EVs to account for between 10 to 50% of all new vehicle sales in 2030. Adoption rates will be greater in dense, developed cities with strict emissions rules and high consumer incentives. The main challenge for EVs is customer acceptance and battery costs. Some manufacturers are already deeply invested in the electrification phenomenon, such as Tesla, Nissan, Renault, and Volvo.

The fourth trend being studied is a change in industry boundaries, leading to a new type of competition and cooperation. Industry players will be obligated to compete on different fronts while simultaneously cooperating with their competitors to ensure long-term viability. As mobility is shifting to new services, new entrants are thus appearing. Mobility providers, tech giants, and emerging OEMs (Original Equipment Manufacturers) reshape the industry, further complicating it. Software competency is becoming a strong differentiating factors. The industry standards on comfort, power, and design are now combined with new technical values.

In the past, manufacturers have focused on innovation in performance, comfort, or features. Naturally, due to the four trends described above, customers' needs and expectations are also changing. Players' business models must adapt to the current market and valuable factors (autonomous technology, electrification, mobility, and connectivity). Manufacturers and industry players must build a different kind of ecosystem, a more complex one, if they want to remain competitive. From electrification to connectivity or self-driving technology, we are entering a new phase of the automobile industry. In this paper, we analyze variations in the industry due to one of the four trends mentioned, the electrification of cars.

1.2) The electric car

1.2.1) History of the electric car

Dr. Stijn Kelchtermans (2018) explained during a presentation at Uhasselt that the first electric car was built in 1897 by the American Electrical Vehicle Company. Unfortunately, this vehicle was ahead of its time. Due to the creation of the ICE, a decrease in gasoline price, and the introduction of the Ford Model T and its assembly lines, the electric driving system was no longer competitive and, therefore, abandoned.

Kelchtermans further affirmed that it was almost a century before electric drivetrains were again considered by manufacturers (during the 90's). This second chance was provided by the constantly growing concerns about environmental impact. Governments increasingly signed agreements to reduce pollution and emissions. For example, the California Air Resources Board wrote a Zero Emission Vehicle Program. The objective was to reduce emissions from mobile sources. Its main goal was to achieve zero emissions in 10% of the vehicles produced in California by 2003. But once again, due to high prices, low autonomy, and changing government policies, electric cars failed to become a strong element of the market.

The third attempt started some years ago and is still on-going. Many factors favor electric cars to succeed in the automobile industry. First, environmental concerns are still relevant and are even becoming more important. Recycling, energy savings, and emission reductions are part of our everyday life. Additionally, some governments such as Norway or Denmark act as examples for the other governments by providing strong incentives in favor of the adoption of electric cars. Many governments are investing heavily in EV infrastructure and mobility programs. Furthermore, the price of electric cars is decreasing. This is largely due to a reduction in battery prices and the subsidies provided. Finally, consumer demand is also evolving. Many environmentally conscious consumers want to reduce their carbon footprint. It is also important to note that an electric car could lead to cost savings, depending on government subsidies. In Norway, EVs are more attractive than ICEs due to exemption from the purchase tax, value added tax (VAT), toll road charges, registration tax and annual circulation tax… for the drivers of EVs, of course.

1.2.2) How does an EV work?[1]

To explain clearly how an electric car works, we can study how the fastest production car of the moment is running, the Tesla Model S, thanks to Learn Engineering (2017). The main components of an EV motor are the induction motor, the inverter, the lithium-ion battery packs, and the synchronized mechanism (See Appendix 1 for an illustrated explanation).

The induction motor has two main parts: the stator and the rotor. The stator receives a three-phase alternating current (AC). It produces a rotating magnetic field (RMF) with four poles that induces current in the rotor bars to causes the rotor turn (it is important to note that the rotor speed is always lower than the RMF speed). The induction motor speed depends mainly on the frequency of the AC supply, which is managed by a variable frequency supply drive. Thus, if the power supply frequency is varying, the drive wheel speed is also varying.

Once the power has been produced, it is transferred to the drive wheels through a gearbox. A single speed transmission is sufficient due to the motor efficiency. A differential can also be found in the gearbox to adapt the speed drive.

But an important question remains unanswered: Where does the motor receive its power from? The batteries produce direct current (DC) power, but it must be transformed into AC. For this purpose, the EV technology uses an inverter. Additionally, the inverter controls the AC supply frequency and, therefore, the motor speed. The inverter may, thus, be seen as the electric car brain.

Concerning the battery pack providing the DC power, it is nothing more than a collection of typical lithium-ion cells. All the cells are connected in series to supply the power needed for the electric car to move. Glycol coolant moves through metallic inner tubes in the gap between the cells. In the Tesla Model S, 7000 cells are divided between 16 modules in the battery pack. After, the warm glycol travels to a radiator usually in the front of the car to be cooled down.

[1] Functioning of the Tesla Model S inspired by the video “How does an electric vehicle work” on YouTube. Link: https://www.youtube.com/watch?v=3SAxXUIre28&t=361s

1.3) Electric car barriers

To build a consistent and strong ecosystem, EV supporters face a number of barriers to overcome. Before analyzing the ecosystem needed around the electric car, I find it important to first study the actual barriers that electric cars must resolve to be successful in the near future. Some barriers are partially consumer oriented. Other barriers are align more with the creation process and the running of EVs. We can see that the barriers concern all actors involved in the ecosystem: producers, customers, suppliers, regulators, etc. These barriers can be divided as follows: price, limited choice, range anxiety, charging, electric demand, battery, and the environmental cost of production.

1.3.1) Price

The high initial price of EVs is still seen as the greatest barrier to their mass adoption. Even if the maintenance costs are lower for an EV, consumers continue to face difficulties in matching the considerable basic investment to own an electric car.

This high initial price is explained partly by the high cost of batteries. Much research and development was needed to create powerful and reliable batteries. Currently, many manufacturers are still working on improving autonomy.

Additionally it has been shown that an electric car faces more difficulties in retaining its value than a gasoline or hybrid car. According to Kathryin Diss (2018), an electric car is worth 63% of its initial price after 1 year. In comparison, an ICE car maintains more than 90% of its initial price after 1 year. The high initial price of electric cars, strong doubt about their reliability, and the actual low demand for this technology may contribute to this difference. In addition to this, as for each new technology, the product and the market are evolving rapidly. An electric car today could become completely outdated within 3 years. Thus, consumers have greater advantages in waiting 5-10 years before acquiring an electric car, as technological improvements will be stabilized.

1.3.2) Limited choice

Even if the electric car market is expending sharply, it will be many years before the range of electric models will be as wide as the range for ICE models. According to Zoran Radosavljevic (2017), “There are just 20 BEVs on sale in Europe, compared to 417 petrol and diesel models.” Additionally, many electric models are not even available for sale in showrooms. Moreover, when ordering an electric model, there are exceptionally long delivery times due to a lack of manufacturing capacities. It is difficult for brands to invest in expensive assembly lines, as sales are not erupting. Thus, they will not see a return on investment directly.

It seems that most manufacturers invest time and money in developing their own electric technology. However, as we have seen, these brands are not providing many of their electric models to customers. How can this observation be explained?

One potential reason manufacturers keep their technology proprietary is to take advantage of the learning effect. They prefer to let other brands gamble on the market while improving their own technology per market reactions and changes. Thus, they will appear on the market a few years later with a fully mature technology. Doing so allows them to reduce investment in electric cars. Moreover, it allows them to build a strong brand image of manufacturers invested in ecology without being subject to failures on the market.

As most manufacturers think in this way, it creates a huge barrier to the infiltration of electric cars. The choice remains limited for consumers; models are not available to them; and nobody wants to be the first to suffer the learning effect in the market. As a result, consumers’ anxiety regarding electric cars is still predominant in their mind. Is it not better for automobile giants to collaborate and leverage this market together for a greater future? Is it possible to transform long standing competitors into partners?

1.3.3) Range anxiety

Range anxiety is the constant feeling that an electric car will not be able to fully travel or reach the next charging point. This constant fear from citizens stands against the introduction of

electric cars. In comparison with ICE vehicles, electric cars face many difficulties in covering longer trips.

Concerning the most famous EVs, Rikki Gibson (2018) drew a clear comparison of various EV capacities. Tesla produces the best results in terms of self-autonomy. The Model S can run 500 kms without needing to recharge. The Tesla Model X and Tesla Model 3 achieve an autonomy of 380 kms and 350 kms, respectively. The Chevy Bolt also presents a satisfactory result of 380 kms. The other EVs available on the market offer slightly worse results: the Nissan Leaf at 240 kms, Volswagen EGolf at 200 kms, Hyundai Ionig at 200 kms, BMW I3 at 180 kms, and the Kia Soul at 180 kms. These results seem sufficient for the daily movement of most consumers. However, they are much lower than typical ICE cars, which can cover approximately 800 kms on a single tank.

Charging infrastructure

In addition to the limited autonomy of EVs, the charging infrastructure is not as developed as the gas station infrastructure. Charging infrastructure needs more time to resolve the different defects to compete with the gasoline ecosystem.

However, some troubles have increased customer uncertainty about the efficiency of electric cars. Many consumers encounter issues when they search for a charging point. First, Loren McDonald (2018) demonstrated that only 49,000 charging connections exist in the world, compared to 1,200,000 pump connections. Most electric manufacturers argue that, proportionally, there are far more charging points per vehicle than pump stations for ICEs. Nevertheless, it is still difficult to find a spot on our roads. Additionally, if the charging spot is taken, one cannot just drive 2 kms to the next point (as for gasoline cars). Consumers must drive approximately 10 or 15 kms. Combined with the limited autonomy of these cars, we face a large problem.

Moreover, it is sometimes difficult to see these charging spots. Gasoline infrastructure features impressive constructions that are easily detectable. In contrast, charging spots are small installations placed next to parking. Even if parking a car safely while charging is the best solution, these charging spots are more difficult to detect from a wider view. Second, while

looking for a charging spot, conductors must often modify their ideal itinerary. In addition to the longer charging time needed, it represents an important loss of time.

1.3.4) Charging

Consumer behavior

Charging an EV takes much more time than filling up on gasoline. It is not possible to arrive at the charging point and leave it with full-recharged batteries after 5 minutes. Consumers must shift how they interact with fueling infrastructure. Due to the time needed to charge an electric vehicle, it is advisable to do it most often while at home or at work to avoid any loss of time. Plugging in must happen more frequently than refueling; it should be done daily. However, as Thibaut Miserque told me, there is a huge problem for people living in urban areas. A large part of them does not have access to a garage or a parking. Therefore they do not have the possibility to plug in while at home on daily basis. As we know the electric car suits best for urban moves. Those people could be interested to invest in an electric vehicle if this point could be resolved.

It also requires more organization from consumers. An EV driver cannot drive on the energy reserve without knowing where to recharge. In contrast with the ICE ecosystem, the limited autonomy and incomplete infrastructure for electric cars lead more quickly to power failure. The comfort offered by the ICE infrastructure is a strong barrier against the introduction of EVs.

No uniform charging system

The concept of charging an electric car is relatively simple. It is nothing more than plugging the car into a charger that is connected to an electric grid. Nevertheless, all charging systems are not equal. There are typically three categories of EV chargers: level 1, level 2, and level 3 (also known as DC Fast Charging). Kristi Brodd (2018) provided pertinent explanations of these charging systems. Chargers categorized as level 1 use 120V AC. They can be plugged into a standard outlet and used at home, at work, or in public places where a simple outlet is available. These chargers do not need additional installations to be effective. Examples of such devices are Duosida, Leviton, or Orion.

Level 2 chargers can be found both at residential and public charging spots. The current provided is more powerful: 240V for residential locations and 208V for public places. One major negative is that they cannot be plugged into a typical wall outlet; they are mostly installed by professionals. These chargers do not need more than two hours to fully recharge a battery. However, the main disadvantage is that many electric car manufacturers have created their own level 2 chargers, tailor-made for their own models (e.g., Nissan). Unfortunately, these proprietary designs slow down the building of the electric ecosystem. A uniform, standardized system (like for telephones) would be more effective for the introduction of EVs.

Figure 1.3: The different charging systems.
Picture from the article *"An Overview of Electric Vehicles and Charging Stations"*

The next level is the DC Fast Charger (Ex: CHAdeMO, CCS). As clearly explained on the website (www.evsafecharge.com) in the article "DC Fast Charging Explained" (2018), they are typically used in commercial places or for industrial purposes. Unlike levels 1 and 2, DC fast chargers do not provide AC (AC must be converted into DC to be stored in batteries). These fast chargers directly produce DC (compatible with the batteries). Therefore, DC chargers can be directly connected to the car batteries and generally provide a powerful current of 120kW. They can charge 80% of a car battery in less than 20 minutes. Even if they offer a relatively low charging time, they also have many disadvantages. First, DC chargers require complicated, technologically advanced equipment to be installed and maintained, which means a higher cost. Afterwards, most of the PHEVs and some EVs cannot be charged via a DC charge, for example, the Nissan Leaf. Moreover, DC charger producers do not collaborate. Thus, cars

using CHAdeMo chargers cannot use CCS devices. Again, this proprietary design confuses the situation and increases potential customers' anxiety.

Battery direct replacement

Even if some chargers can recharge a battery in 30 minutes, it is still too long in comparison with refueling ICE vehicles (approximately 3 minutes). This delay may result in waiting queues, especially during peak periods, which can lead to customer dissatisfaction. To resolve this long waiting time, many businesses have studied the possibility of swapping the discharged battery for a fully charged one in a dedicated swapping station. Rather than 30 minutes for DC chargers, only 5 minutes are needed for the battery swapping system.

However, the cost to develop and build these stations internationally is too high. Additionally, few models are suitable for battery swapping. BetterPlace, a company that built 55 battery swapping stations in Denmark and Israel, went bankrupt in 2013.

The greatest problem remains a lack of collaboration between manufacturers and charging companies in creating a consistent product. Too many different possibilities exist; every company has tried to establish their own idea without thinking to the entire system. All businesses invested in EVs are more focused on strengthening their market position than helping the ecosystem to grow. There is no common line from car manufacturers and charging station providers. Without strong, common pillars, it is too difficult to build a powerful ecosystem.

1.3.5) Electricity demand

If EVs are claiming greater market shares in the future, then ecosystem members encounter new questions. An important topic concerns the domain of electricity demand.

Green energy supply

The principal aim of EVs is to reduce pollution by reducing gas emissions. However, turning to electric technology also means a higher need for electricity. To remain green cars, the used electricity should come from green production. Unfortunately, the renewable energy production system is not as developed as it should be.

The main energy source of electricity production is commonly determined by the country where one is located. Once again, Norway has generated remarkable results with most of its

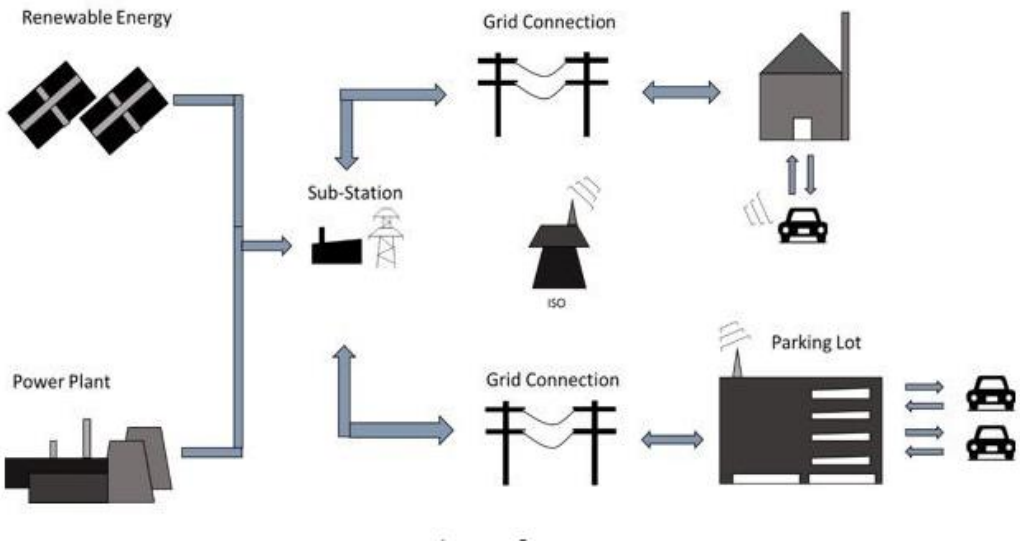


Figure 1.4: Electricity provision for electric cars.
Picture from the article *"How Electric Vehicles Can Drive Renewable Energy Forward"*

electricity production coming from hydroelectric power. However, the electricity generated from renewable sources is not dominant in every country. Each country is dependent on pollutant production sources. If EVs succeed as expected, authorities will be confronted with additional electricity demand. However, as said before, the renewable energy system is already used maximally. Thus, the more electric cars on our roads, the less green energy will be used to run them. This discrepancy represents a problem for the green character of EVs.

Peak period

The consumption of electricity is not entirely regular. With households, work locations, or public places, there are always dead and peak periods during the day. This phenomenon will be even more accentuated with the introduction of electric cars. According to Nicolai Mallig (2015), it has been shown that the electric energy curve (only for EVs) is at a minimum during the morning and reaches its maximum at 6 pm, when people are back from work and plug-in their vehicles. This time is also the busiest of the day, when the grid is already providing the maximum amount of power possible. However, in many countries, the electricity provision

system is not yet ready to support extra charges from EVs. As it may lead to power cuts, the ability to deliver additional electricity during peak periods must be improved.

1.3.6) Batteries

Cost

As stated before, the battery is one of the main reasons for the high cost of EVs. Most of the batteries are lithium based with a mix of cobalt, graphite, nickel, and manganese. These materials are exceedingly difficult to find and extract. Following Andreas Dinger and Ripley Martin (2017), the manufacturing cost of a battery pack was more than 250€/kWh. The usual model of both the Nissan Leaf and the Volkswagen EGolf has a 40kWh battery pack. More sophisticated products, such as the Tesla Model S, use a pack of 100kWh. As shown through a simple calculation (250€ x amount of kWh), the battery pack of the Nissan Leaf costs approximately 10,000€ while the Tesla Model S battery pack would cost 25,000€. Even if this cost decreases over time, it still represents an impressive high cost to consider.

Recycling

As Laurence Neve told me, the recycling process represents a strong obstacle for the electric car introduction. What happens when lithium-ion batteries are out of service? Joey Gardiner (2017) stated that only 5% of lithium-ion batteries are recycled. Obviously, this percentage is not enough, and it has an impact on the environment. First, there is a risk that the battery will spew toxic gases. Additionally, due to this poor recycling percentage, core ingredients need to be extracted again. However, these resources are finite. As noted above, the extraction of cobalt or lithium is also a source of pollution.

Even if some regulations are learning to manage battery recycling, an important question remains: Who will finance the cost of collecting, treating, and recycling the used batteries? Government? Carmakers? Clients? Following some emerging regulations, it seems that car manufacturers will be responsible for the battery recycling program.

The last important question about recycling concerns how it happens. Some actors may prefer to recycle the different components of the batteries, while other members choose to re-use

the battery for different purposes (e.g., kitchen appliances). There is no best solution, but battery recycling must be studied as soon as possible to avoid further trouble.

1.3.7) The environmental cost of production

The ecological footprint should not be measured only with vehicle gas emissions during use. The entire process to build a car, the provision of required materials, and the distribution system should also be considered. Some studies have argued that EV conductors must run between 50,000 and 100,000 kms to produce less gas emissions than ICE drivers.

It has been shown that the production of EVs contributes highly to the global warming. For Jonathan Eckart (2017), to produce an electric car, manufacturers use double the energy compared to the production of a combustion engine car. Once again, the main reason is the battery. Creating a battery requires significant energy. From the extraction of raw materials to the electricity used by the manufacturer, the creation of a battery is not environmentally friendly.

Eckart (2017) confirmed that the other percentage of pollution is largely due to the processing of those materials. Creating batteries is a long, pollutant, and costly process. Furthermore, other related production problems arise. For example, KU Leuven (2018) affirmed that more than 60% of the cobalt supply comes from the Democratic Republic of Congo. As we know, the Democratic Republic of Congo does not profit much from its natural resources, as large companies exploit those resources without providing fair compensation. Additionally, the conditions of workers extracting the different raw materials are far from optimal. Their safety is not always ensured, and the damages to the workers' health could be important. For example, the extraction and the smelting of nickel engenders deformations and respiratory problems.

Chapter 2: How the car industry is going to change

2.1) An innovative EV ecosystem

2.1.1) The ecosystem in general

The first use of the word “ecosystem” was during the 1930’s. A botanist, Arthur Tansley, used this term to describe a community of organisms interacting with each other and their respective environment. These organisms were defined as competing and collaborating with the other organisms to evolve and adapt themselves to environmental changes.

In 1993, James Moore adapted this biological concept. He stated that networks between companies should be studied from a larger standpoint than the perspective of individual organizations. Organizations are members of an ecosystem with actors playing across various industries. In an ecosystem, all members are connected. Thus, they share the benefits of a potential success. On the other hand, with a failure, the entire ecosystem suffers the negative consequences.

Moore (1993) also highlighted the dynamic characteristic of an ecosystem, saying, “Over time, members co-evolve. They align their abilities and roles with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments and to find mutually supportive roles.”

Some of the main goals of an ecosystem include the following:

- Encouraging collaboration to address social and environmental challenges
- Enhancing creativity and innovation
- Boosting the learning process by sharing skills and knowledge
- Building new incentives to face human needs

2.1.2) Electric vehicle ecosystem

EV key stakeholders

Our EV ecosystem model is built by giving specific places to members of the EV ecosystem and by defining the various relationships among them. Before constructing our model, it is important to identify the principal stakeholders active in the ecosystem.

- **Resource extractors** are the first actor in the construction of EVs. Without the extraction of primary resources, it is not possible to trigger the production chain.
- ***Battery suppliers*** execute a key role in the creation of an EV. Batteries are the main components of the electric car and a major point of differentiation between the electric concept and the usual gasoline motorization.
- ***EV manufacturers*** regroup all the companies involved in the building and delivery of electric cars. They occupy a significant role in the ecosystem with many activities and actors linked to them.
- ***Battery recycling companies*** perform an essential role in the background of the ecosystem. They carry out all activities in recycling the end-of-life batteries. Even if the ecosystem could function without them, they provide real capital gain.
- ***Mobility service providers*** include all the tangible companies offering additional mobility possibilities (e.g., taxi) and the intangible businesses proposing software or hardware in line with mobility (e.g., Uber).
- ***Power network operators*** are the different actors whose main activities are the creation and distribution of electricity in the required places at the right time.
- ***Regulators*** encompass all the policy makers from any levels of government. They could be member states, international institutions, national governments, or local authorities. Each of them has a role to play at its own level.
- ***End customers*** represent consumers that use EVs for their usual mobility or specific uses. End customers may be private buyers, companies, or public entities. They represent the final element of the ecosystem.

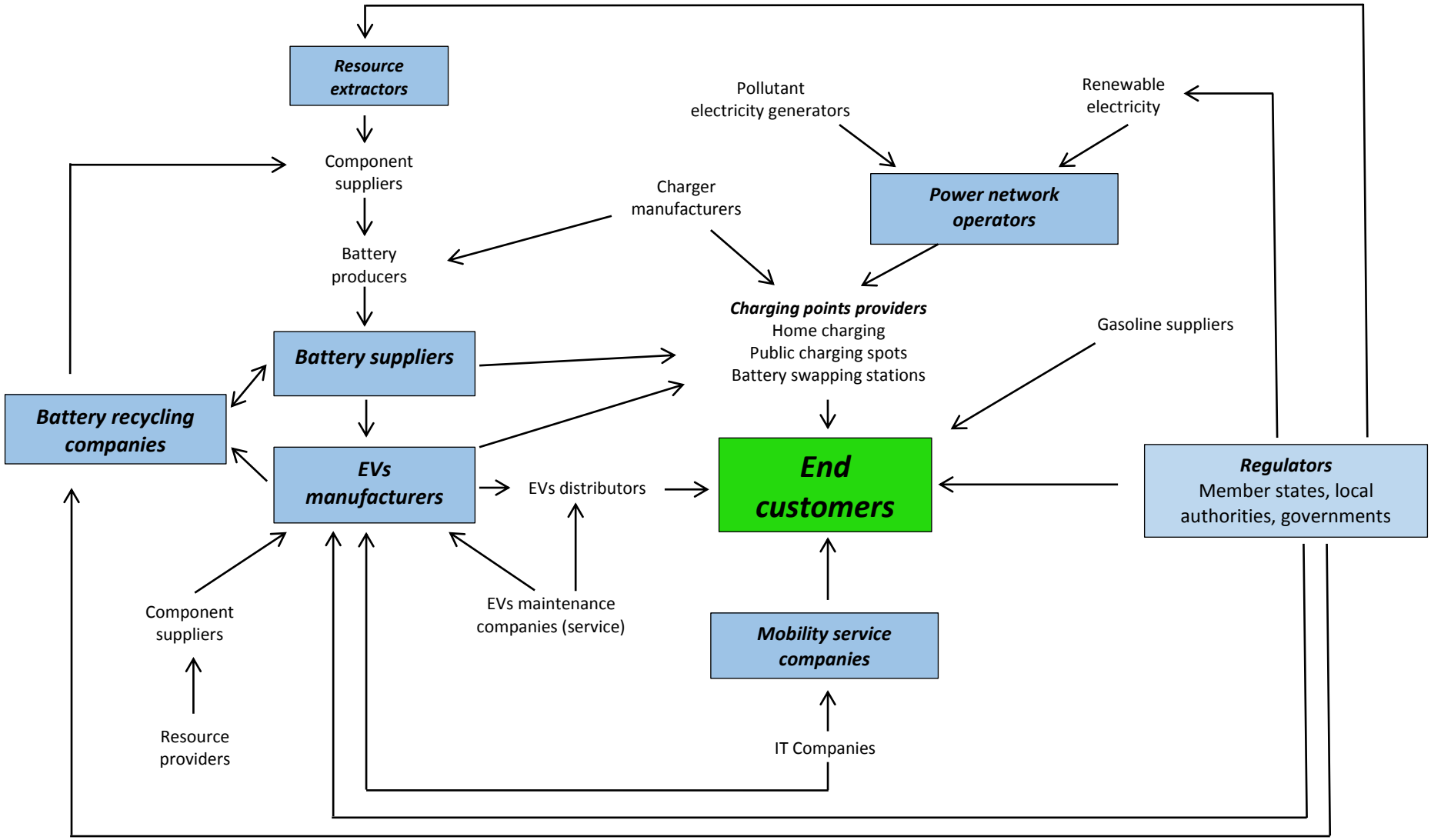


Figure 2.1: The electric car ecosystem

Explanation of the EV ecosystem

In the ecosystem drawn above, the eight key stakeholders can be identified by blue boxes with a green box representing the final decision maker, the end customer. This young ecosystem is already complex, with many different supply chains and numerous links.

Let us start the analysis with the central element of the production chain, ***the EVs manufacturers***. To build their electric cars, manufacturers receive the several components from their own component suppliers. To form and create these components, the component suppliers must also receive primary or secondary resources from resource providers.

As we know, batteries can be considered as the most vital component of the electric vehicle. To create a battery, many natural resources must be collected and extracted by the ***resource extractors*** (lithium, nickel, or cobalt). Afterwards, the extracted resources travel to the component suppliers before reaching the battery manufacturers. The constructed batteries are sent to the ***battery suppliers***, who act as an intermediary for acquisition by the EVs manufacturers. We note that some manufacturers create their own batteries. Thus removing two intermediaries in the provision chain: battery manufacturers and battery suppliers.

As said before, we are facing a battery waste problem. Therefore, it is essential to invest in ***battery recycling companies*** for the ecosystem welfare. Regulators, EVs manufacturers, and battery suppliers must work together to find the best solution. Naturally, this will lead to a compromise from each. However, without a solution for end-life batteries, the ecosystem cannot be successful on the long term.

To finally reach the end customers, EVs manufacturers use distributors. Additionally, maintenance providers are needed to ensure perfect and strong after sales service.

We can now turn to the electricity provision section. There are two main types of electricity generation: pollutant production and renewable electricity generation. ***Power network operators*** are used to distribute the energy at the right moment to the required charging places (home or public spots). Battery swapping stations can also be used as charging points; battery suppliers are responsible for the provision of these. Finally, to ensure the creation of

a fluid ecosystem; charger manufacturers, charging point providers, EVs manufacturers, and battery manufacturers must progress together to create common charging systems, usable by the full range of EVs. Fuel suppliers are also a source of energy for customers. However, in this ecosystem, they represent a negative point as they will attempt to hinder the growth of electric cars.

When we talk about automobiles, we also means mobility. As such, ***mobility service providers*** play a strong role in the building of the ecosystem. To surpass the ICE, mobility service providers must believe in the new electric car generation. Moreover, connectivity is a new trend that mobility providers can exploit. Therefore, IT companies play a crucial role in the building of software and hardware to create this connectivity through the electric car. By collaborating with EVs manufacturers and mobility service providers, IT companies can reinforce the electric car value proposition.

The last point to address is about the ***regulators***. As we see on the graph, regulators are linked to many actors. In fact, they appear as the driving force of the ecosystem. First, regulators can push electric cars to the end customers through incentives provided. As we know, Denmark and Norway are two ardent supporters of this kind of initiatives. Second, regulators are responsible for regulations and laws. The actions of EV manufacturers depend partly on those laws and the freedom given. Regulators must provide the means to companies if they want to succeed. Third, to resolve the problem of natural resource extractions, regulators must boost the creation of a battery recycling process by investing or enhancing the creation of recycling infrastructures. Finally, to be as green as possible, the energy used by an EV must come from renewable production. This is the responsibility of the government to create the renewable infrastructure required to produce increasingly green energy in the near future.

As we have seen, the ecosystem of electric cars is complex. Everything is interlinked and interdependent. No point can be neglected without leading to negative consequences for the other members and the whole network. In the next two points, we will identify the four types of roles within an ecosystem and how leveraged collaboration between members can help the ecosystem to progress further.

Four main roles within the ecosystem

Following Moore's ideas on the ecosystem (1993), members can be divided into four main behaviors, all having an influence on the ecosystem function.

- ***Physical dominators*** are members who try to develop horizontally and vertically to control a larger part of the network. They want to minimize the freedom left to other members of the network. This kind of member leads to negative consequences for the network by reducing diversity, killing competition, and limiting consumer choice.

  In our ecosystem, most of the EV manufacturers can be seen as physical dominators. They want to increase their control on the network by expanding their domain of activities. In addition to cars constructors, some of them also become the battery manufacturers and suppliers, component suppliers, EV distributors, or maintenance service providers. As said before, this lack of diversity leads to negative consequences due to the poor exchange of knowledge and capabilities. To create a successful future for electric cars, manufacturers must increase their collaboration with outside actors and their direct competitors. They must learn how to decrease their control over the ecosystem to leverage it better. At the end, the value they receive will be greater if they allow the other members enough freedom to exploit their capabilities.

- ***Value dominators*** execute little control. However, they try to extract as much value as possible while offering limited value. These actors also have negative impacts on the overall ecosystem. They do not bring enough value to create a sustainable ecosystem. At the same time, they are focus only on their personal wealth.

  We do not have any obvious value dominators in our EV ecosystem. If we must choose one actor to illustrate this role, I would choose fuel suppliers. Fuel suppliers do not create much value for the EV network. However, they try to impede its development. The more electric car adopters on the road, the less fuel consumers will need. Fuel suppliers want to extract the most value possible from the whole car ecosystem without bringing positive elements to the network. The only element provided by fuel suppliers, is fuel.

- ***Keystones*** are members that create and share value for the ecosystem. Commonly, keystones exercise a function of system regulators. They are not looking to grow their personal received value. Keystones are more focused on the whole ecosystem wealth before they consider their own wealth. Keystones are clearly positive and necessary for running an ecosystem.

  Regulators are the perfect example of a keystone. As the name implies, the regulators' main function is to regulate the system. Via rules and agreements designed by the various regulators (members states, governments, and local authorities), they act as the main driver of the EV ecosystem. Regulators create and share value for the ecosystem, mostly through incentives offered to the end customers. Additionally, many helpful resources are available for the other actors. This help could be in the form of subsidies or via regulations adaptations to provide the necessary means for companies. Clearly, regulators are a crucial element of the development of the ecosystem. The success of electric cars depends highly on them.

- ***Niche players*** are responsible for most of the value and innovation created by the ecosystem. Niche players develop skills and knowledge that differentiates them from the other actors within the ecosystem. They also enhance the creation of complementary resources with the other actors of the ecosystem.

  When looking at the ecosystem, the main body of actors are niche players. Renewable electricity generators, power network operators, charging point providers, charger manufacturers, resource extractors, battery recycling companies, battery manufacturers and suppliers, or IT companies and mobility service providers are all niche players. These actors engender much of the value proposed by the ecosystem. Each mentioned player has developed specific and typical skills, knowledge, capabilities, and rituals. These each make them unique and are essential for running the network. If each of them is focused on improving their knowledge and value creation while thinking to the whole ecosystem wealth, there is no doubt that electric cars will take off in a near future.

Roles	***Real life examples***
Physical dominators	10 years ago, when Renault decided to launch an electric range, they wanted to become a pillar of this new industry. From a common manufacturer, they decided to diversify themselves to other domains. Component supplier, battery manufacturer, or battery swapping provider, Renault wanted to occupy a multifunctional role in the ecosystem.
Value dominators	As said before, fuel suppliers may appear as value dominators in the general automotive industry. For example, the company Royal Dutch is extracting many petrol resources in poor countries without thinking about the environmental consequences. They also charge higher prices than needed to create more value for themselves to the discharge of the whole ecosystem benefits.
Keystones	In Norway, the government acts perfectly as a keystone. Norway is doing the maximum to help the ecosystem. First, road users driving an electric car do not have to pay annual road tax. In addition, those users can park for free at municipal parking in cities. Secondly, companies that buy electric cars enjoy a 40% reduction of their company car tax. Third, more generally, electric cars are exempt from the 25% VAT on purchase. Moreover, there is no purchase taxes on imported electric vehicles. As we can see, Norway authorities try to boost the ecosystem by creating value for a large majority of the ecosystem actors. (Petra Zsuzsa Lévay, Yannis Drossinos, Christian Thiel; 2017).
Niche players	• CHAdeMO and CCS are two companies specialized in EV chargers production. Even if it seems not that important, chargers are required to allow a strong ecosystem. Creating

	chargers require specific skills and knowledge. This small niche market must be perfectly up to date. • Kemetco, a battery recycling company, has created a laboratory scale recycling of rare components as the lithium, nickel, or cobalt. It brings a real plus for the whole industry.[2]

2.1.3) Collaboration needed

As we have just seen, EV manufacturers would like to expand their activities as much as they can to gain a greater share of value from the electric car penetration. As they are the main actors of the electrification trend, it is understandable. However, electric technology and the entire ecosystem are too complex for this plan; they cannot create everything themselves. Even if they possess many resources, it will not be sufficient. The ecosystem must be based on collaboration and mutual help. The exchange of knowledge, skills, resources, and ideas must be enhanced to leverage the electric car market.

As said before, each actor of the ecosystem has influence on the other actors and, thus, the overall ecosystem. Therefore, it is not possible to neglect a part of the ecosystem or to allow it to be less efficient. While working on their own technology, each player must think about its long term viability but also about the ecosystem welfare. Once again, the main solution for this concern is to collaborate effectively and openly. The manufacturers of EVs must increase their external collaboration with partners, suppliers, or customers. A collaborative ecosystem goes beyond the typical industry and organizational boundaries. The companies' mind-set must be built around the spirit of collaboration.

We have seen in the chapter on barriers to entry that many barriers arise due to a lack of uniformity. For example, there is a strong problem with the charging system. Some people work in favor of the battery swapping stations while other actors are implementing charging spots. Moreover, the charger outputs are never compatible for the entire range of electric

[2] http://www.kemetco.com/

cars. Everybody is working on their own product and system without any real collaboration between manufacturers, charger manufacturers, and charging station providers. How can the ecosystem become consistent with such silo mentality? A shift is needed.

Concerning the viewpoint of batteries, we also face a problem of collaboration. Each manufacturer is working on its personal battery technology. They are all improving their own system day after day. Nevertheless, by sharing knowledge, skills, and ideas together, they could easily and quickly create a better battery system. Additionally, collaborating would decrease the cost of production of batteries (one of the most important problems faced by EVs). If they all adopt the same technology and system, they can achieve higher economies of scale. The whole ecosystem would benefit from a collaboration concerning the battery production.

It would also be interesting for these members of the electric ecosystem to work together to leverage the green character of the electric car. First, the renewable energy infrastructure could be more developed. Second, the recycling process of batteries is far from being optimal. If all the actors work collaboratively to improve the negative points described above, it would be an incredible boost for the electric car introduction. Many barriers to entry can be removed by promoting collaboration.

In the ICE ecosystem, car manufacturers and the different members were working in an ecosystem that was already built, and which was strong, efficient, and consistent. Therefore, they can be focused on their own benefits and personal interest. As everything was already well implemented, competition took the lead over collaboration. However, constructing such an ecosystem requires decades to be so shaped. Members of the young electric car ecosystem cannot adopt the same mentality as the ecosystem rules and boundaries are not developed enough. Some companies have understood this and are now shifting their way of thinking. Tesla is a prime example of this shift.

Tesla is known for the more sophisticated technology of electric cars. Tesla cars are the fastest, have the highest autonomy and profit from a fast charging system. Instead of keeping its technology secret within their four walls, the management decided to open its IP and

guaranteed no legal action against other manufacturers, intending to stimulate the EV market and ecosystem. Elon Musk (Tesla director) explained this new mentality: “It is impossible for Tesla to build electric cars fast enough to address the carbon crisis. Our true competition is not the non-Tesla electric models, but rather the enormous amount of gasoline cars pouring out the world every day.” Musk is a strong believer that the entire world would benefit from a common and rapid evolution of electric technology.

Nevertheless, it is important to keep a bit of competition inside the industry. As Benoit Galand explained us, competition is crucial if we want a technology to progress quickly. It forces the various players to work harder and faster in order to propose the best product. This is how the technology is always improving day after day. To ensure a strong ecosystem, electric actors have to find the right balance between collaborating/sharing and competing. For example: manufacturers can collaborate with charger creators to adopt the same system for each car. At the same time, they can compete on the technical part of their products to propose a better car to the market.

Here are some examples of collaboration between actors in the ecosystem:

- Sibeg and Nissan[3] (the bottler of products from Coca-Cola) have signed an agreement to increase the introduction of electric cars in Sicily. This agreement included 110 new Nissan Leaf vehicles (electric) and eight fast-charging stations. Sibeg is not partnering only with Nissan. They have also formed a partnership with ALD Automotive to execute administrative and management services.

  Benefits for the ecosystem: growing infrastructure and improved mobility services.

- Nissan has joined its capabilities with Eaton[4] to create better energy storage. Eaton will take the used batteries from Nissan, then the batteries will be converted to carry out new tasks and increase energy storage capacities.

  Benefits for the ecosystem: battery recycling and decreasing natural resource extraction.

[3] https://newsroom.nissan-global.com/releases/release-75b19d3a1fdacef5055230314513dd33-nissan-and-sibeg-partner-to-develop-a-new-electric-ecosystem-in-italy

[4] https://www.nissan.co.uk/experience-nissan/electric-vehicle-leadership/xstorage-by-nissan.html

- Renault has also changed its approach and is now investing much in partnerships.[5] First, Renault has invested in *Jedlix*, a charging application for smartphones. Currently, they own 25% of this Dutch company. The objective of Jedlix is to improve consumer behavior while charging, which should lead to regulated energy consumption.

  Benefits for the ecosystem: better charging behaviors and regulated electricity consumption.

  Second, Renault has also formed a partnership with "*We Drive Solar."* This company is a defender of the charging stations supplied only by local, solar-powered electricity. *Benefits for the ecosystem: renewable energy generation.*

  Finally, Renault is collaborating with *Powervault*, a business specializing in home energy storage. Together, they want to offer a second life to used batteries from Renault cars. They want to use these batteries to store the energy generated by solar panels.

  Benefits for the ecosystem: battery recycling, decreasing natural resource extraction, and renewable energy generation.

- IBC Solar has entered a partnership with EV Box[6]. Through this partnership, EV Box will provide charging stations to IBC for private and public use. The objective is to promote photovoltaics energy generation and adapt it directly for electric cars.

  Benefits for the ecosystem: renewable energy generation and growing infrastructure.

- The program Ionity[7] is the result of knowledge sharing between BMW, Daimler, Porsche, Audi, and Volkswagen to launch 400 charging stations usable by a wide range of electric cars. They are working together to construct a common system usable on multiple electric brands.

  Benefits for the ecosystem: common chargers and growing infrastructure.

[5]https://group.renault.com/en/news/blog-renault/renault-a-proactive-player-in-the-electric-vehicle-ecosystem/
[6]https://www.ibc-solar.com/
[7] https://www.daimler.com/innovation/case/electric/ionity-2.html

- BP, the fuel giant supplier, is talking with many EV manufacturers to install charging spots in their stations[8]. Shell is following the same idea by offering charging spots in some of their stations in the UK and The Netherlands.

  Benefits for the ecosystem: growing infrastructure.

- The European Commission is investing much money in partnership with manufacturers, universities, cities, and research institutions to exchange knowledge and experience to facilitate the introduction of EVs in Europe.[9]

  Benefits for the ecosystem: boost given from the government, common direction to work, lighter rules to allow more freedom.

- Suzuki and Toyota are working together to quickly introduce EVs in India. Both companies will have distinct roles.[10] Suzuki will produce the cars and supply some of them to Toyota. In contrast Toyota will be responsible for technical support and act as a distributor in India.

  Benefits for the ecosystem: availability of EVs, improved distribution, effective maintenance services.

[8] https://www.theguardian.com/environment/2018/jan/30/bp-charging-points-electric-cars-uk-petrol-stations
[9] https://ec.europa.eu/transport/themes/urban/vehicles/road/electric_en
[10] https://qz.com/1133216/suzuki-toyota-partnership-why-marutis-entry-into-indias-electric-vehicle-segment-is-such-a-big-deal/

2.2) Value blueprint

2.2.1) The value blueprint in general

If we want to evaluate an ecosystem and to understand it further, a value blueprint is the perfect tool. A value blueprint is a tool that serves to define the status of an ecosystem. It helps us to assess the value proposition of the ecosystem and more easily illustrate what can be improved and what is already strongly implemented.

Ron Adner (1996) defined the value print as follow: "When the value proposition requires multiple elements to converge, you need an approach that will allow you to assess alternative configurations and generate shared understanding and agreement among the partners as to how these elements should come together… Left unarticulated, contradicting visions do not conflict until commitments are made and pieces are brought together. But when the strategy meets reality, details become disasters."

To construct a consistent and reliable value blueprint, George Tanev, Peyo Tzolov, and Rollins Apiafi highlighted that it is essential to move from a product-centric approach to an ecosystem-driven approach. Thus, it allows to identify valid key stakeholders, creating a representative plan, and establishing the proper links between actors.

Doctor Stijn Klechtermans (2018) affirmed that a value blueprint helps to overcome implicit assumptions about structure. It can be seen as a map explicitly detailing an ecosystem and its relationships or dependencies. A value blueprint clarifies the collaboration needed in the ecosystem and some potential risks that may arise due to the different relationships.

To build a value blueprint, six steps are commonly applied:

1) Identify your end customers
2) Identify your project, what you need to deliver
3) Identify suppliers
4) Identify intermediaries
5) Identify complementors
6) Identify risks in the ecosystem

Concerning the last step, Ron Adner (1996) explained that two main questions can help you identify the various risks: “What level of co-innovation risk does this element present?” and “What is the level of adoption risk this element presents?”

Adner (1996) went even further describing risk identification. He said that colors must be used to make the risks and the value blueprint of the innovation even more understandable.

Colors	Co-innovation risks	Adoption risks
Green	Already implemented.	Partners want to be involved. They see some potential benefits from increased involvement.
Yellow	Not implemented but there is a plan to do so soon.	Partners are neutrals. They are open to innovation, but it is not their priority.
Red	Not implemented and there is no plan, no strong initiatives planned.	Partners have more to gain from the status quo than from the innovation. They will not invest themselves.

His reasoning can be summarized as follows:

After having constructed the value blueprint, two more steps must be realized. First, for each partner characterized with yellow or red dots, it is interesting to focus on and understand the problem in order to suggest viable and adapted solutions. Second, as the market and the world are changing rapidly, our basis value blueprint can promptly become outdated. Therefore, the blueprint must be updated on regular intervals. The model must be as representative as possible of the actual market.

2.2.2) The EV value blueprint adoption risks

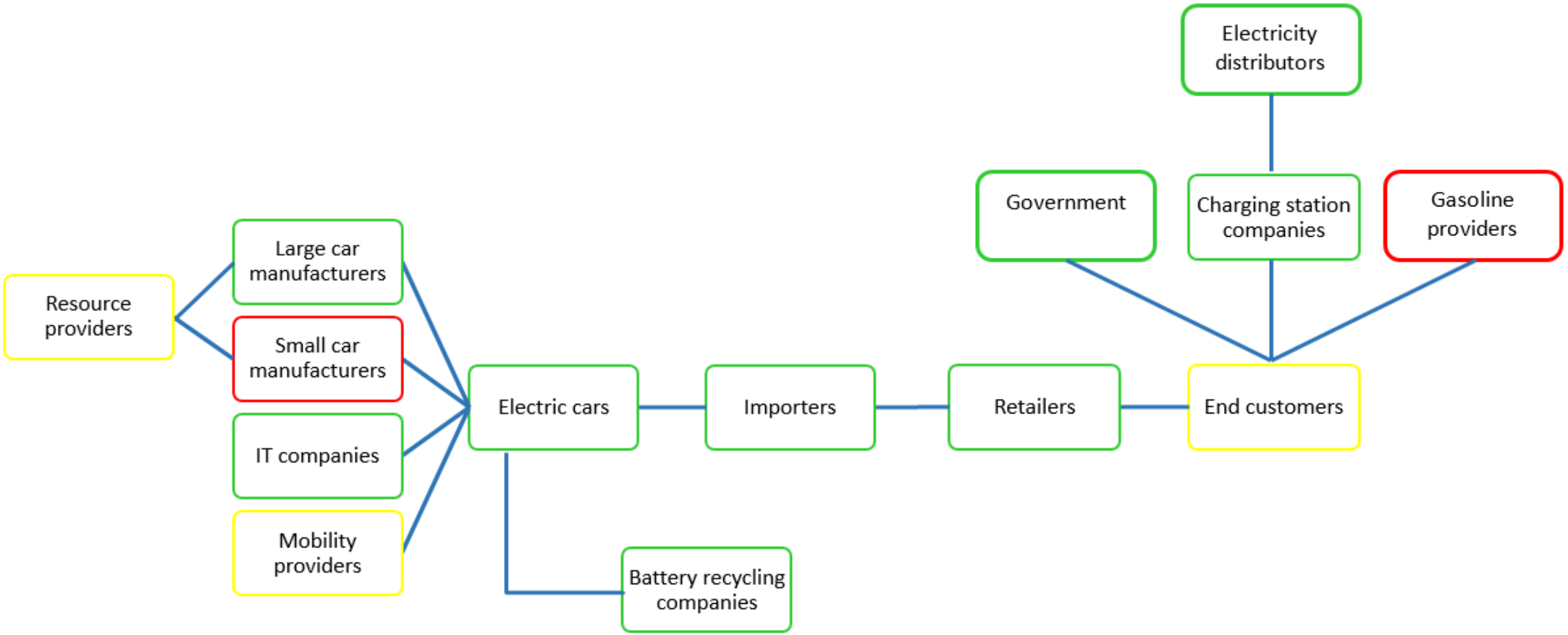


Figure 2.2: Value blueprint adoption risks over electric cars

As stated before in this chapter, the adoption risk relates to the partners' willingness to undertake required activities or innovation. To clarify, I followed the method of Ron Adner by using colors to define the level of willingness. While looking at this relationship graph, many points can be underlined. Let us analyze it in a logical way by following the chain.

First, resource providers received a yellow dot. As we talked earlier in the chapter on barriers to entry, the production of an electric car requires twice as much energy as an ICE vehicle. This need represents a positive point for them, as it enhances their business and strengthens their importance in the supply chain. However, the working conditions and use of natural resources (for example, to create the batteries) stands as a highly negative point. The extraction process of rare components, such as lithium or the nickel, is far from ecological. Additionally, there is an over-use of some poor countries concerning the resources provision.

While looking at car manufacturers, a distinction must be addressed between large/important manufacturers and smaller producers. On one hand, large manufacturers are characterized by a green dot. If they want to follow market trends and remain competitive on the long term, these important automobile actors must invest in electric cars and increase their involvement in the ecosystem. The market penetration of EVs offers new opportunities for them. Therefore, the adoption risk for large car manufacturers is extremely low. Alternatively, small car manufacturers such as Gillet Vertigo, PGO, or Caterham have more to lose from the growth of electric cars. These manufacturers do not possess the same amount of resources as large groups like Volkswagen or PSA. It would be harder for them to invest enough funds in electric technology to follow the market. Therefore, this group is characterized by a red dot; these entities have more to gain from the status quo than from the electric change.

The IT companies are colored with a green dot. The introduction of electric cars offers them more possibilities. There is a growing need for IT skills to build consistent and reliable electric cars but also to develop software and hardware dedicated to the electric generation.

Mobility providers can be divided into two main groups. Tangible providers encompass buses and taxis, for example. Intangible providers gather applications, such as Uber or additional services, to ensure a fluid mobility. The introduction of electric cars will create a huge change

in their habits, but it should not disturb their business and revenue streams. They stand as neutral.

For the distribution chain (importers and retailers), green dots are used. These functions also must follow the market changes, and therefore, they must be open to the electric wave. Importers and retailers will pursue the directions given by their brand manufacturers. Manufacturers and the distribution chain must work together for electrification success.

The introduction of EVs also creates new, related markets, such as the recycling of used batteries. The first movers who invest in battery recycling are 100% positive for car electrification. If electric cars succeed, it will be an incredible boost for their market. They are prepared to involve themselves even more.

If we look at some end-customer related partners, we directly see that electricity providers and charging station companies are drawn with green dots. Normally, these actors would be some of the greater winners from EV infiltration. In contrast, gasoline providers (such as Shell or Texaco) have everything to lose from the electric wave, as their main revenue stream would be over.

For the government adoption risk, it varies from country to country. Nevertheless, most governments are in favor of the green car. As we have seen in Norway or Denmark, the government proposed strong incentives in favor of electric car adoption. In general, it is not the government that has more to gain from electric cars. However, they act as a driving force behind the adoption of EVs in their country. Commonly, governments are clearly involved in ecosystem building.

The last member of the value blueprint is the end customer. A yellow dot is used to underline their neutral position. Even if some of them act as innovators and are favorable to electric technology, end customers are not yet ready to turn from the gasoline concept to the electric one. Range anxiety, limited choice, and high prices are the foremost barriers from a customer perspective. Due to their limited openness concerning electric cars, they are characterized by this yellow dot.

2.2.3) The EV value blueprint co-innovation risks

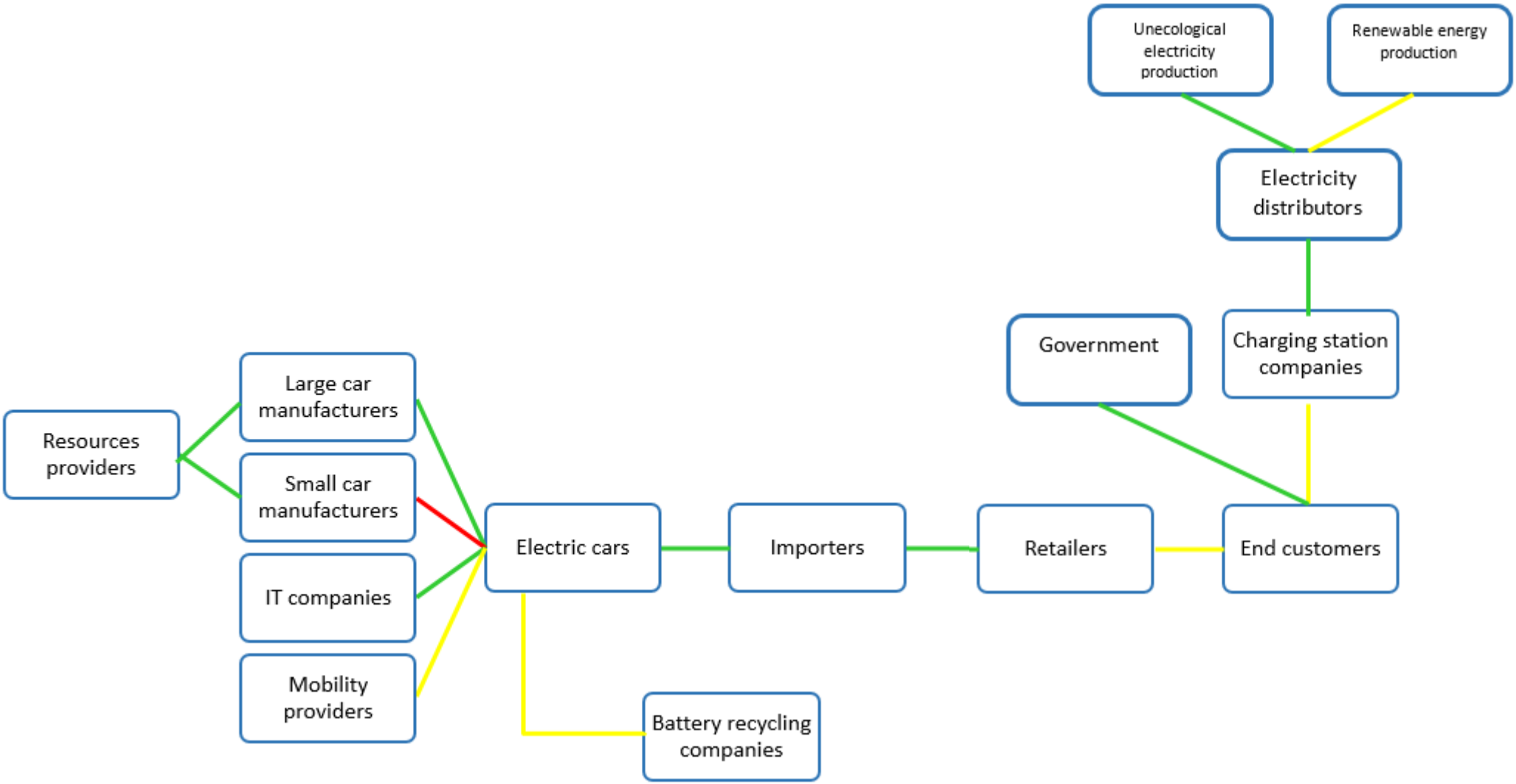


Figure 2.3: Value blueprint co-innovation risks over electric cars

The co-innovation risk describes the ability of the members to undertake the required activity to create an effective and efficient ecosystem. In this case, we examine what can be improved to increase the proposed value of electric cars (see table above for the meaning of the colors). In this discussion, we see that all the elements are interdependent and must be perfectly implemented to ensure a viable proposed value. If only one point is inefficient, it slows down the entire ecosystem and hinders product development.

The only relationship in red which means not implemented and without any plan concerns the relationship between small car manufacturers and electric cars. As stated above, it is difficult for small automobile companies to bring together the required funds and skills to develop their electric technology. They will be followers of the market when economies of scale and learning effect decrease the cost of production.

It is interesting to see all the green lines already present in the value proposition. These lines represent all the relationships already implemented in an efficient way. However, some points must still be improved or acted upon to achieve an interesting offered value from the ecosystem. Yellow lines illustrate these nuanced relationships. All these yellow lines represent a brake on the launch of EVs. Even if it seems to be a second-hand problem, it must be resolved to progress further.

First, mobility providers and electric cars are not collaborating much. It is true that electrification is largely an internal revolution (concerning the motorization of vehicles), rather than innovation about the way people are moving. On the other hand, this new wave represents new opportunities for service providers such as Uber to take advantage of the first mover phenomenon. Electric cars are the perfect tool to bring greater connectivity to the market without disturbing industry boundaries.

Second, we see that battery recycling also represents a point to be improved. Currently, only 5% of end-life batteries are recycled. Authorities, carmakers, and governments are working on different solutions to increase the yield of used batteries. As Adner would say, there are many plans, but it is not well implemented. To ensure the success of the ecosystem, the entire car lifecycle must be considered. Therefore, this battery recycling problem must be resolved

as soon as possible. It will also partially resolved a problem in background activities, the resource extraction. The more we recycle, the less we need to extract natural resources.

Once again, when we look at the distribution chain, we see a positive green color dominating the importers and retailers. This link is not the most difficult cooperation to foster. Electric cars can mainly use the distribution chain of ICE vehicles that is already well optimized. However, there is still a gap between the retailers and the end customers. The chapter "Barriers to entry" demonstrated that EVs are rarely exposed in the showroom and that car sellers are not pushing many models to the customers. If retailers want to reach their end customers, they need to involve themselves more with the final consumers to ensure a complete and efficient chain.

The last point concerns the generation and the distribution of electricity. A major problem of electric cars is the provenance of used electricity. Many authors argue that "An electric car is as green as the energy it uses." As we see in the value blueprint, the production of unecological electricity is already well developed and implemented. However, the principal aim of EVs is to be environmentally friendly. Thus, governments want to increase the production of renewable energy. Nevertheless, this line is drawn in yellow. Even if they are many projects and agreements to expand renewable energy infrastructure, they are not yet implemented. Moreover, the projects and regulations always face delay constraints. To ensure an entirely green system, increasing renewable energy production is a primary concern.

The last yellow line concerns the link between the charging station companies and the end customers. Even if the provision of electricity should be sufficient to support the integration of electric cars, the provision to the end customers via charging spots is not developed enough. It is difficult to find a spot while driving and to be sure that this spot is not busy. As this point is related to end customers, it must be resolved to decrease customer anxiety and to finally launch the final advent of electric cars.

As we see, the EV value blueprint is on a better way to be effective in the near future. Even if some yellow lines remain present, they could be turned green if all the actors collaborate and help each other.

2.3) Business model innovation

2.3.1) The Business model in general

To conclude this section about the changes that the introduction of electric cars will create, it is interesting to study the business model of electric car manufacturers and how it will disrupt the industry.

Afuah (2004) defined a business model as follows: “A business model is the set of activities a firm performs, how it performs them, and when it performs them as it uses its resources to perform activities, given its industry, to create superior customer value and put itself in a position to appropriate the value.”

Chesbrough (2001) added that a business model is about creating value and capturing a part of the value created. Amit (2004) saw a business model as the content, structure, and governance of transactions designed to create value thanks to the exploitation of business opportunities.

According to Johnson (2010), a business model can be divided into four primary elements to create and deliver value: customer value proposition, profit formula, key resources, and key processes.

- The value proposition concerns the offered value of a product. How a product can help to cover a job? How effective is a product? How affordable is the product?
- Key resources include people, facilities, equipment, brands, technology, etc. Key processes regroup the way of working, various activities, and possibilities to create the product and to deliver value. Together, key resources and key processes form the value chain configuration.
- The profit formula describes how the company will benefit from their activities. Naturally, it also includes a part in relation to the cost of developing the product as fixed costs and assets, for example.
- Key processes define all the operational and managerial processes that allow the company to run, repeat sales, and to growth.

2.3.2) The old business model

To clearly understand the change in the car manufacturers' business model, it is important to talk some about the business model for ICE companies.

- Their main value proposition is to deliver high-quality cars with opportunities for personalization. Everyone can choose some features depending on their own needs. Moreover, consumers benefit from a large choice among ICE vehicles and a large infrastructure for distribution or maintenance.
- Concerning the value chain configuration, the manufacturers build the cars and are also responsible for the supply and the distribution to the final consumers. The consumer decides who will execute the possible reparation and the maintenance operations. To guarantee a reliable mobility, fuel companies insure the distribution of gasoline/diesel to the consumers.

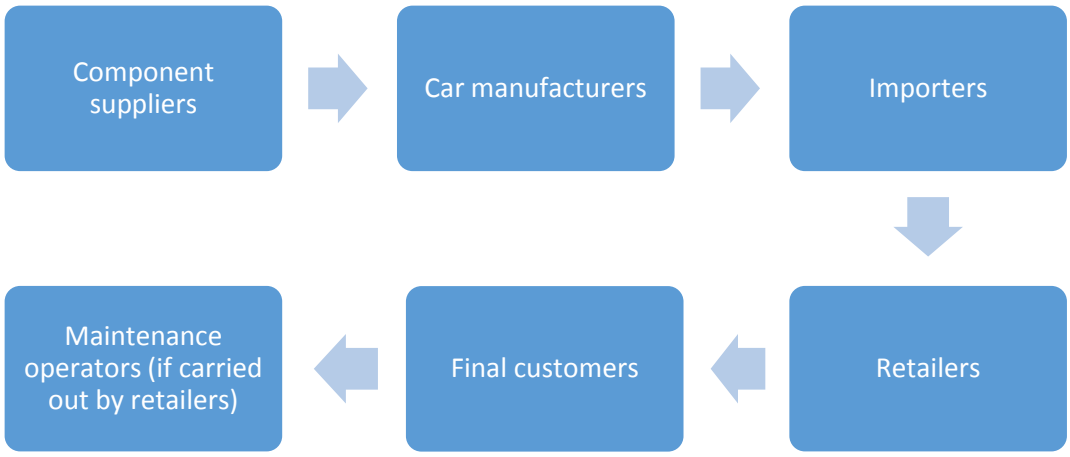


Figure 2.4: Value chain of the internal combustion engine model in brief

- So far, the revenue model includes three main revenues for gasoline car manufacturers: the sales price, leasing rates, and maintenance services (when handled by the manufacturer).

In the past, manufacturers were more focused on creating high-end vehicles with numerous features and growing comfort. The motorization part was already well developed; they have not been working much on engine improvements in the past few years. A large part of the

business model described above cannot be transferred to future mobility based on electric cars, mainly because of technological restrictions.

2.3.3) An innovative business model

The value proposition

We are not talking anymore about comfortable and high-end cars. The main value proposition of an electric vehicle is its green characteristic due to the use of electricity. In contrast with an ICE vehicle, an EV is environmentally friendly. Even if the production is less ecological, the electric car diffuses zero emission while moving.

A second related element of this value proposition is the possible integration of renewable energies in the ecosystem. By producing electricity via solar panels, wind turbines, or from hydrogen sources, the electric car is the only solution to create a green automobile ecosystem. Even if we are still very dependent on pollutant electricity producers (such as numerous power plants), green production infrastructure is of primary concern for actors in the electric car network. If renewably generated electricity increases, it will become a convincing argument to attract potential customers that are still reluctant.

The third value proposition of the EV concerns the running cost. An EV requires less maintenance than a usual gasoline car. This improvement is possible because of simplified motorization and the lower price of electricity in comparison to gasoline car.

Fourthly, the electric vehicle offers an incredible comfort. As Thibaut Miserque noticed, the electric car is really smooth and easy to drive. In addition, it is purely silent. It makes driving even more relaxing. Moreover, there is no noise pollution for pedestrians or cyclists which is very interesting for cities.

Some governments also play a role in this attractive value proposition by providing subsidies and advantages to electric cars buyers; they provide a plus point to this value proposition. As illustrated before, the Norwegian government has reduced taxes for EV buyers. They have also allowed free access to parking spots in some cities. Furthermore, EV drivers benefit from an exemption of circulation taxes. Naturally, these rewards are part of the value proposition.

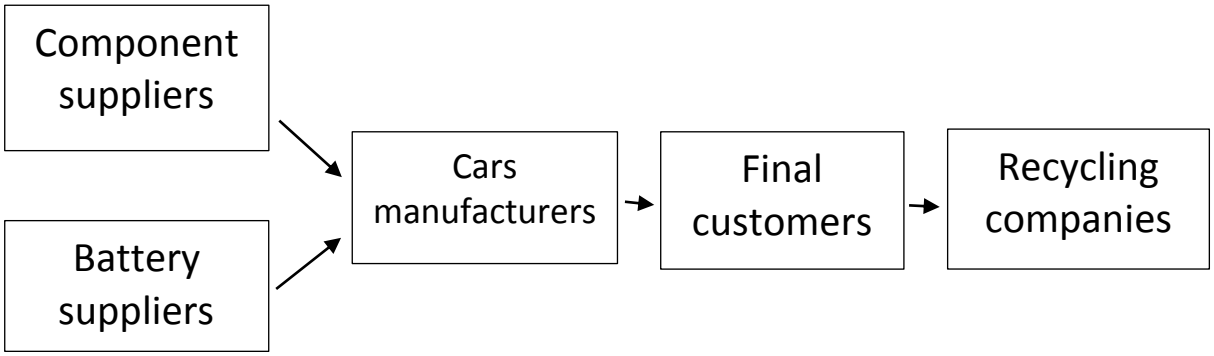


Figure 2.5: Value chain of the electric vehicle model in brief

The value chain configuration

The value chain of EV manufacturers will also be modified due to the electric car growth. First, new actors are entering the value chain with a crucial role to fulfill. It will affect the manufacturers' downstream and upstream channels. This is the case of battery producers. In the past, a battery had limited importance in the typical gasoline car. Presently, the electric motor needs the battery to run; their role is far more important. Thus, battery producers become a major element of the new value chain. Concerning the upstream members, the charging station providers enter as an important new actor. They are going to replace the fuel providers on our roads. Finally, the upstream value chain will host a new member, recycling companies. To optimize the efficiency of the whole electric system, waste must be reduced. Even if we do not see many recycling systems, their apparition is expected in the near future. Their main domain of activity will be focus mainly on the batteries. But the other components of the electric car must also be considered.

Connectivity is also going to influence a lot the value chain configuration. Thanks to many digital devices, customers can find all the necessary information on the Internet. The information role of retailers is becoming obsolete. Connectivity also allows direct contact between car manufacturers and their end customers. For any question or problem, the end customer can directly join the manufacturers without having to use intermediaries.

Maintenance operators are also going to disappear. First, they will suffer from direct connections between manufacturers and end customers. Second, the EV engine is easier and less costly to maintain. Maintenance operators will be one of the main losses from the electric car introduction.

Changes in the revenue model

The revenue model will also be changed due to electric cars. Revenues from sales will remain a major part of the revenue stream. They should not see a meaningful decrease or increase in sales in the future.

As for the old business model, leasing will still be applied. However, the system should be adapted slightly. As we know, electric cars cost more to produce and less to maintain. Due to the connectivity phenomenon, it is easier to control the customer behavior. Currently, the leasing principle is based on the period the car is rented. Nevertheless, it would be interesting to study the possibility to rent a car on a kilometers-traveled basis. The more kilometers you travel, the more you pay. Obviously, a minimum must be established.

The car industry must prepare itself to face the disappearance of maintenance activities. Cars are increasingly reliable, and the motorization system of an EV is more basic. Furthermore, connectivity provides access to a large panel of information in case of problems. It is easier to find the needed information or to reach someone with the required knowledge when necessary.

In the future, data monetization will represent a huge revenue opportunity for the automotive industry. Companies such as Uber, Apple, or Google are heavily pushing to use more effectively the data collected from cars. Connected cars, autonomous driving, and ride sharing are current examples of the attention attached to data from vehicles. Many OEMs argue that the next decade will lead to new activities related to data collection as data gathered on consumers, vehicle use, driving behavior, location, environmental information, etc. Collection, analysis, and marketing of these data will create new activities for actual players or new entrants. If managed well, these data can also be sold to specialized, automobile related companies or survey makers, for example.

As discussed before, there is a growing possibility of business from the recycling of used components of the car. The introduction of EVs reinforces this opportunity. Companies will see new revenues from battery recycling or re-use. It is also important for them to optimize

the life cycle of the other components, such as the rotor, the inducer motor, or the various metals from the car. Large business opportunities are emerging in this field.

From the cost perspective, there are three main changes to talk about. First, car production is more expensive for an EV than an ICE vehicle, mainly due to the battery process. Second, as for all recent technology, significant effort in research and development is needed to create a strong ecosystem and an attractive product for the consumers. If the EV ecosystem wants to be as competitive as the ICE ecosystem, money must be invested to strengthen its value proposition. Third, new costs arrive due to the connectivity domain. New skills in IT and data manipulation are required to take advantage of the opportunities mentioned above. This goal can be accomplished by hiring new people with the required knowledge or by forming partnerships.

Other OEMs business models

The introduction of EVs is not influenced only the actual business model. From energy production, to charging spots supply or from OEM offerings to mobility services, the electric car is challenging actual business models while providing opportunities for the creation of new ones. Some OEMs and new entrants are studying new business models.

Navigation software/apps in line with charging infrastructure: Users of EVs need to know the location of charging stations but also if the station is free and compatible with their vehicles. Moreover, it would be interesting to make a spot reservation in the future. This could be possible with growing connectivity and consumer behavioral changes.

Charging services: Services related to payment, access, and registration to charge your EV are not yet well implemented. An opportunity is present to improve and optimize the system.

Battery leasing: Some companies are currently studying the possibility of installing a concept based on the battery leasing, independently of the vehicle purchase. As we know, batteries represent a huge disadvantage for the ecosystem. This could be a possible solution.

Grid applications: As we stated before, peak periods represent a danger for the power infrastructure. To manage the introduction of EVs and the possible peak periods, smart applications are needed to regulate charging.

To conclude, the automotive industry will see radical changes in its three main components. Electric vehicles engender higher cost but it will also lead to new revenue streams. Industry players must follow the market and adapt their business model to remain competitive on the long term. The world is changing quickly; if they do not take the initiative, other entities will. The electric car market can easily shift from a great opportunity to a fatal threat if actors do not adapt their business model.

Chapter 3: Case Study, government as a locomotive

When we talk about the car industry, many people tend to forget that the government represents a main actor. However, all governments do not express the same interest in electric cars. Some of them are strongly committed to allowing a future launch while other ones are just respecting some law agreements on the environment because they must. Nevertheless, as mentioned before, electric success sharply depends on government interventions.

In this last chapter, we study three ways to promote electric cars from the government perspective: electrifying public transport, incentives to buy, and investing in the EV industry.

3.1) Electrifying public transport

As studied previously, electric cars are on the best path toward launching a new wave in the automotive industry. Step by step, the ecosystem is linking the various actors to increase the proposed value. However, customer uncertainty over EV capacities is still important. A possible solution to reduce this uncertainty would be to electrify public transport. It could show the efficiency and welfare of electric cars to all consumers.

It is proven that smog (due to car gas emissions) is one of the main reasons behind the death rates in cities. A possible solution to resolve the smog problem is to make the city circulation as green as possible by providing green facilities for public transportation. Some cities are already working in this direction. For example, Paris is promoting green public transportation. The City of Lights wants to invest more than €400 million to install 1000 electric buses. In Asia, the city of Shenzhen is the first city in the world equipped with electric buses only. More than 16,300 buses are running in this city (12 million inhabitants). To support the large number of electric buses, Shenzhen has also invested in 510 charging stations and 8000 charging poles.

In Switzerland, as Laurence Neve from Kyburz explained me, the post is equipped with 7000 electric tricycles (produced by Kyburz). As the post office knows exactly how many kilometers

each tricycle is performing on a day, power cuts are limited. Everything can be planned to ensure a reliable supply.

In India, the government is working actively to ensure public transport is completely electric in the future, promoting e-mobility. They started a dedicated programmed in 2015 to boost the electric introduction through electric buses, three-wheelers, and shared cabs. The investment represents a huge amount of money (3000 buses, 2400 four-wheel taxis, and 21,500 three-wheel taxis). The government took the lead by providing incentives to leverage this ambitious program.

Four arguments are typically in favor of the electric generation for public transportation from the government perspective:

- Improving citizens' lives in cities by decreasing gas emissions and noise pollution.
- Green public transportation can be the first step toward creating a new industry.
- Many governments want to reduce their fuel dependencies.
- It is positive to show an environmental and green attitude.

3.2) Incentives to buy

As we all know, electric cars are far more expensive than typical cars. Even if the maintenance and running costs are lower, the initial investment is more important to private households. In some countries, to push citizens to invest in EVs, governments are providing huge incentives. These incentives can be financial (such as tax exemptions or subsidies given) or non-monetary.

Norway is the primary example to follow in term of incentives offered to citizens. They are strongly promoting electric transportation. For common gasoline vehicles, the taxation system is based on engine power, CO2, and NOX emissions. Moreover, the VAT rate must be approximately 25%. Electric vehicles are exempt from all these taxes. Additionally, they are partially exempt from the annual circulation taxes. Petra Zsuzsa Lévay, Yannis Drossinos, and Christian Thiel (2017) highlighted that the financial benefits of owning an electric car represent

half of the net buying price after four years. Furthermore, companies investing in EVs enjoy car taxes 50% lower than for ICE.

Norway is also offering non-monetary advantages. First, electric car users can drive on bus lanes and receive a free access to public parking. Additionally, more than 4,000 public charging stations are provided for free. Thus, the running costs are decreasing even further, closer and closer to zero.

Norway is also working heavily to help the ecosystem to grow. For example, they are providing subsidies to battery producers to develop and improve technology. They are also investing in green energy infrastructure to ensure a sufficient supply for EVs. It is expected to reach a rate of 25% green electricity production in 2035.

Naturally, with such incentives, the rate of electric cars is growing highly in Norway. It is the country with the best rate of EVs in the world. In 2016, sales of electric cars reached a market share of 21%. With such great statistics, other governments are following Norway example, such as Denmark, France, UK, and Germany. It shows clearly how the government can be the leader of the electric car success. Step by step, citizens' uncertainty is decreasing due to government efforts.

3.3) Investing in the EV industry: Caterpillar Gosselies

While many incentives and efforts are directly consumers linked, the government can also work on the foundation of electric cars. It is important to ensure a viable ecosystem success.

The Belgian government is trying to increase its involvement to popularize the electric car. Increasingly, charging points are sprouting in public places and strategic locations. The government is dedicating money specially to install additional electric charging points. In addition, the Flanders government is offering subsidies between 2000€ and 4000€ to electric cars buyers. In Wallonia, electric car drivers enjoy a circulation tax well lower than for gasoline cars. But especially, for few months, the government has been working on a big project concerning the electric car: Gosselies and Thunder Power.

For more than two years, the buildings of Caterpillar Gosselies have been abandoned. Recently, the Walloon government tried to find a new destiny for the Caterpillar site. They convinced Thunder Power to relocate in Gosselies as the center for their European introduction and production.

Thunder Power is a new car manufacturer focused on electric technology. Its headquarters is based in Hong Kong (China) and the manufacturing department is in Ganzhou (China). They also perform research and development in Italia. They are specialized in the luxury sector. Many people see Thunder Power as a future competitor for Tesla in Europe and have named Thunder Power as “The Chinese Tesla”. While offering sophisticated luxury cars, Thunder Power is also selling its models at far lower prices than their range competitors.

To allow their European introduction, €300 million of investment are needed for Thunder Power. The Sogepa, a financial part of the Walloon region, agreed to unlock more than €50million to invest in the creation of Thunder Power Belgium for the European market. The project is to use the ex-Caterpiller buildings to install assembly lines. “Chloé,” the electric city vehicle from Thunder Power, is supposed to be the model constructed in Gosselies. The final aim is to assemble more than 30,000 vehicles per year in Gosselies.

In addition to electric advantages for the ecosystem, it is expected that 350 jobs will be created in 2020. Three years later, more than 200 jobs should be created again. The general region wealth has a lot to gain from the Thunder Project. Despite an important initial investment, large positive consequences are expected for the electric ecosystem and the region health.

Conclusion

"If you go back a few hundred years, what we take for granted today would seem like magic – being able to talk to people over long distances, to transmit images, flying, accessing vast amounts of data like an oracle. These are all things that would have been considered magic a few hundred years ago." said Elon Musk CEO of Tesla.

This phenomenon is exactly what we are experiencing now. Most drivers do not think a significant change is possible in the car industry. In their mind, this industry is too large to face a radical change in the future, such as electrification. It is true that the electrification of the automotive sector will completely change users' habits and perceptions. However, we can notice that the gasoline concept is presently facing some limitations. A change is needed. Currently, the electric car ecosystem seems to be the most promising successor to the old gasoline model. However, the ecosystem is not ready yet.

As we have seen in the chapter on electric car barriers, there are still many obstacles present that disfavor the electric vehicle. The main problem is the price and the high initial investment to buy an EV. Even if the running costs are lower than for ICE driven cars, this initial investment represents a huge financial burden for a majority of the population. Moreover, people struggle to trust EV technology. The electric car must cope with the range anxiety of many citizens (the feeling that one's car is not going to reach the destination or any charging point). This negative feeling is reinforced by the limited charging infrastructure. Also, the charging method is problematic. Manufacturers and industry players are not collaborating enough to create a consistent universal charging system. Therefore, many different charging systems have been developed independently, instead of building an effective technology for all members. Finally, the foundations of the EV ecosystem are also not optimized: The electricity supply is too dependent on pollutant production methods; the battery recycling system is currently not well developed; and the environmental cost to produce an electric car is still too significant.

Even if strong players are present in the electric ecosystem, none of them has all the skills needed to overcome these barriers alone. Clearly, more collaboration is necessary if industry players want to see the ecosystem progress further. When an innovative technology appears

on the market, there is much to win for industry players. Naturally, each of them tries to optimize its gains. However, this profit orientation is detrimental to the ecosystem. It would be much better to leverage the whole ecosystem, together, to increase gains for all actors in the ecosystem. By sharing skills, knowledge, and ideas or by working together on the same project, industry actors can create a consistent and viable value proposition for their target market.

It is easy to see some domains in the EV ecosystem where improved collaboration is needed (e.g. the charging system). Each manufacturer is creating its own chargers without sharing its technology. The same problem applies to batteries. As nobody is collaborating, research on battery efficiency is not optimal. Moreover, price remains important due to the lack of uniformity and economies of scale. Step by step, significant players are realizing this need for collaboration such as Tesla, which is ready to share its knowledge to better leverage the electric car industry.

Naturally, a new ecosystem also means new links and roles between actors. In studying the value print and the co-innovation risks for the electric car, we have seen that many relationships are planned but not yet well implemented. This problem applies to the five important relationships:

- Mobility providers / Electric cars
- Battery recycling companies / Electric cars
- Renewable energy production / Electricity distributors
- Charging station companies / End customers
- Retailers / End customers

To reach a consistent ecosystem, it is critical to work on those relationships as soon as possible. When we try to change an entity as large as the automotive industry, the replacement solution must be perfect. If a single, small point is not optimal, the whole ecosystem can suffer. For the EV to excel, it is critical to enhance these imperfect relationships.

As the industry is evolving, actual business models will become obsolete. Therefore actual players have to adapt their business models to be in line with the electric generation. First, the value proposition of an EV is based on the green character, the low running cost, and the subsidies provided by the government. In the future, this value proposition could be made more attractive by providing a larger choice to consumers and a better ecosystem infrastructure. Second, the value chain must also face some changes. New actors will play a crucial role in the ecosystem as battery producers, charging station providers, and recycling companies. However, some actual players will suffer from the electric ecosystem, such as the maintenance operators. They may well disappear due to the direct contact between manufacturers and customers, as well as the low running cost of an EV. Third, the revenue streams must also change. As we previously stated, maintenance activities are likely to disappear. However, connectivity will offer new opportunities through data monetization and analysis. The profit formula will also experience added cost, such as the hefty cost of creating an electric car, more research and development to improve technology, and new charges due to the connectivity domain.

Finally, we have seen in the last chapter that the government holds a crucial role in unlocking EV growth. The government is the best placed to leverage electric technology and can act as a model/leader to boost introduction of EVs. First, by electrifying public transport, the government can reduce citizens' anxiety. It also demonstrates to the population a proper example to follow in the future. Second, the government can push the electric car to citizens. As we have seen with the Norwegian government, it is important to offer incentives to the population. Doing so helps citizens to switch from the old technology to the new. Third, the government can invest in the electric technology by promoting the backstage, as we have seen with the Caterpillar example. Even if we always think about customer focused incentives, it is also important to develop an entire ecosystem behind the market. Each actor would be grateful to receive some government assistances.

With all the explanations in this paper, we now have a better understanding of how the introduction of EVs is disrupting the car industry. All the customers' habits, way of working,

actors' relationships, roles of the government, methods of using a car, business models, value propositions, etc., will change due to electric technology. Currently, the automotive world is not ready to switch entirely to EVs. But I am sure that step by step with significant involvement from all players, it can become a reality in the future.

As Benoit Galand told me, we are always focused on one new technology to replace the old technology. It is also the case for the car industry. Maybe the solution for the future of the industry is not only the electric car. It would be interesting to study the possibility of a car industry composed of multiple technologies. Gasoline, electric, biomass, hydrogen, etc… Each system has advantages and disadvantages depending on the use. I would like to conclude this paper with an open question for the future: What about an automotive industry with different powertrains depending on drivers' needs?

Limitations and further research

This paper offers a broad view on the status of the electric vehicle at the moment and how it will potentially disrupt the car industry. Moreover, I have paid attention to the EV ecosystem, its problems and some solutions to achieve a higher rate of penetration. However, this master thesis has some limitations.

First, limited attention is attached to government interventions. The government is a strong actor in the ecosystem and plays a crucial role in the EV introduction. It would be interesting, in further research, to precisely analyze the role of the government in this context.

Second, this master thesis is largely focused on the EV manufacturers' perspective. Even if the entire ecosystem is dependent on manufacturers, it would be interesting to study further the role of smaller players and how they can bring extra value to the ecosystem.

Third, this paper does not attach much weight to the technical part of the ecosystem. As we know, technology is becoming a pillar of the modern world. Therefore, technology will play an essential role in ecosystem building. I do not have the skills to provide a detailed analysis on the technical aspects of EVs. Nevertheless, I advise specialized researchers to focus on this subject.

The fourth point concerns the number of case studies. Due to page constraints and time restrictions, I did not have the ability to review more case studies. However, it would have been interesting to study different perspectives from various stakeholders to complete this thesis.

Finally, if electric cars are penetrating the market, it will bring us to a significant question for the future of the car industry: What will be done with the enormous number of gasoline cars currently driving our roads?

Research Methodology

As I am totally passionate by the automotive industry, I was really interested to study further the future of this domain. As we know, the electric car is probably the most likely solution to replace the gasoline concept. However, when we talk about the electric technology, everybody has a different opinion about this solution. Therefore, I wanted to develop my own point of view and to expand my knowledge about the electric vehicle.

As I did not possess important knowledge about this technology, I decided to read a maximum of articles and thesis to understand the subject from a broad view. In the beginning, I chose the articles randomly, only to get in touch with the electric car concept. Step by step, after analysing and comparing all the readings, I went deeper in the subject, choosing precisely the articles I read.

When I read an article, I paid a particular attention to the ecosystem point of view. I really wanted to understand all the components of the electric wave. Moreover, I also found important to understand how the electric car is different from the gasoline car. It helped me to highlight the important changes coming due to the introduction of the electric technology.

When I got an improved understanding, I decided to study the automobile situation at the moment. I wanted to know how the electric car is seen. What is its position on the market? How citizens interact with the electric car? What are the main advantages and disadvantages of the electric car in comparison with an ICE car? I realized that the electric car faced many troubles to replace the ICE model. I wanted to study this point in details before constructing my EV ecosystem.

While studying the problem faced by the electric car, I noticed that many troubles were caused by a lack of collaboration. In my opinion, collaboration between players was the main reason why the electric technology is currently not optimal. This is why I studied deeply how an increased collaboration can help the ecosystem to grow. I also used some internet websites to have precise cases of collaboration in the electric world. At the end, I wanted to propose some solutions to complete my point of view.

After all those analysis, I had enough understandings to construct my EV ecosystem. The ecosystem build in my master thesis reflects my personal vision over this subject. I constructed it according to my feelings and ideas. Naturally, other workers can have another opinion about it. I totally respect their opinions.

After that, I found interesting to collect other perspectives to be more objective about the topic. This is why I did some targeted interviews. I wanted to interview people with unrelated roles in the EV ecosystem to be as complete as possible.

Moreover, I had the chance to attend very interesting classes during my Master in Hasselt University. I decided to use what I learned in school to study other elements in the electric car ecosystem. It helped me to study further the business model and the value blueprint of the electric car industry. By combining some readings and my courses, I could bring interesting elements to this paper.

When I started writing my paper, I did not plan to study the government. However, I have seen an emission on the Belgian television (RTL TVI) about the electric car and how the government can play a crucial role to introduce the electric car on our roads. I found this subject really relevant. Therefore, I decided to demonstrate how the government can be the motor of the electric car introduction. As the government incentives are varying from country to country, I decided to talk about this point only with actual examples of good actors. The purpose is to prove that authorities can invest themselves even more and that those increased efforts can generate impressive results concerning the electric car.

Finally, I had to organize all my ideas in an understandable and pleasant paper to express my point of view over the electric vehicle. I struggled a bit concerning the structure of this paper. I wanted to write this master thesis following the reasoning I had in my mind. It was also important to me to express my opinion and to propose some solutions for our future cars.

References

Adner Ron, Kapoor Rahul. 2016. *Innovation ecosystem and the pace of substitution: re-examining technology s-curves.* University of Pennsylvania: 1-55.

Amsterdam Roundtables Foundation, McKinsey & Company. 2014. *Electric vehicles in Europe: gearing up for a new phase?* 1-60.

Bellekom Sandra, Benders René, Pelgröm Steef, Moll Henk. 2012. Electric cars and wind energy: Two problems, one solution? A study to combine wind energy and electric cars in 2020 in the Netherlands. Centre for Energy and Environmental Studies, Faculty of Mathematics and Natural Sciences, University of Groningen. *In Energy **45***: 859-866.

Biello David. 2016. Electric cars are not necessarily clean. *Scientific American* 11 May: https://www.scientificamerican.com/article/electric-cars-are-not-necessarily-clean/

Binder Alan K., Bell Rae John. 1999. Automotive industry. *Encyclopaedia Britannica*: https://www.britannica.com/technology/automotive-industry

Bohet Florian. 2018. *How the introduction of driverless cars is disrupting the car industry?* University of Hasselt: 1-70.

Bouland Felix. 2018. Thunder Power starts with Cloe city e-car in Gosselies. *New Mobility News* 24 September: https://newmobility.news/2018/09/24/thunder-power-starts-with-cloe-city-e-car-in-gosselies/

Bowman Zack. 2017. DC fast charging for electric cars: what's here, what's coming, what's hype? *Green Car Reports* 23 May: https://www.greencarreports.com/news/1110598_dc-fast-charging-for-electric-cars-whats-here-whats-coming-whats-hype

Brodd Kristi. 2018. An overview of Electric Vehicles and charging stations. *Advanced Technology* 2 May: *https://www.advancedenergy.org/2018/05/02/an-overview-of-electric-vehicles-and-charging-stations/*

Bubeck Steffen, Tomaschek Jan, Fahl Ulrich. 2016. Perspectives of electric mobility: Total cost of ownership of electric vehicles in Germany. Institute of Energy Economics and the Rational Use of Energy. University of Stuttgart: Germany. *In Transport Policy* ***50***: 63-77.

Cartwright Jason. 2017. The city of Shenzhen now has 100% electric buses in public transport system. *TechAU 30* December: https://techau.com.au/the-city-of-shenzhen-now-has-100-electric-buses-in-public-transport-system/

Christensen Thomas Budde, Wells Peter, Cipcigan Liana. 2012. Can innovative business models overcome resistance to electric vehicles? Better Place and battery electric cars in Denmark. Roskilde University Denmark, Cardiff Business School UK, Cardiff School of Engineering UK. *Energy Policy* ***48****:* 498-505.

Clarke Sean. 2017. How green are electric cars? *The Guardian* 21 December: https://www.theguardian.com/football/ng-interactive/2017/dec/25/how-green-are-electric-cars

Deboyser Bernard. 2018. Thunder Power négocie l'implantation de sa future usine européenne à Charleroi. *Automobile Propre* 1 June: https://www.automobile-propre.com/thunder-power-negocie-limplantation-de-sa-future-usine-europeenne-a-charleroi/

De Rousseau Mikaela, Gully Benjamin, Taylors Christopher, Apelian Diran, Wang Yan. 2017. Repurposing Used Electric Car Batteries: A Review of Options. *In The Journal of The Minerals, Metals and Materials Society*: 1575-1582.

Dimitropoulos Alexandros, Van Ommeren Jos N., Koster Paul, Rietveld Piet. 2016. *Not fully charged: Welfare effects of tax incentives for employer-provided electric cars.* Department of Spatial Economics, VU University Amsterdam: The Netherlands. 1-19.

Dinger Andrea, Martin Ripley, Mosquet Xavier, Rabi Maximilian, Rizoulis Dimitrios, Russo Massimo, Sticher Georg. *Batteries for Electric cars.* The Boston Consulting Group. 1-18.

Diss Kathryn. 2018. The big problem with electric vehicle resale prices compared to petrol, diesel and hybrid cars. *ABC News* 6 February: http://www.abc.net.au/news/2018-02-06/electric-vehicle-resale-price-compared-to-petrol-diesel-hybrid/9380186

Eckart Jonathan. 2017. Batteries can be part of the fight against climate change – if we do five things. *Medium* 29 November: https://www.weforum.org/agenda/2017/11/battery-batteries-electric-cars-carbon-sustainable-power-energy/

Energysage. 2018. How do EV charging stations work? Level 1, Level 2, and DC Fast charging. *Energysage* 15 November: https://www.energysage.com/electric-vehicles/charging-your-ev/how-do-ev-charging-stations-work/

Erriquez Mauro, Morel Thomas, Moulière Pierre-Yves, Schafer Philip. 2017. Trends in electric-vehicle design. *McKinsey And Company*: 1-11.

Foehringer Emma. 2017. The next big obstacle for electric vehicles? Charging infrastructure. *GreenTechMedia* 3 November: https://www.greentechmedia.com/articles/read/the-next-big-obstacle-for-electric-vehicles-charging-infrastructure#gs.jDxhNCs

Gardiner Joey. 2017. The rise of electric cars could leave us with a big battery waste problem. *The Guardian* 10 Augustus: *https://www.theguardian.com/sustainable-business/2017/aug/10/electric-cars-big-battery-waste-problem-lithium-recycling*

Gebauer Fabian, Vilimek Roman, Keinath Andreas, Carbon Claus-Christand. 2016. Changing attitudes towards e-mobility by actively elaborating fast-charging technology. *Technological Forecasting and Social Change* ***106****:* 31-36.

Gibson Rikki. 2018. 2018 Electric vehicle range comparison. *Fleetcarma.* https://www.fleetcarma.com/2018-electric-vehicle-range-comparison/

Goldemberg Jose. 2009. Nuclear energy in developing countries. *Deadalus, Fall 2009* ***138****:* 71-80.

Gnann Till, Plotz Patrick, Kuhn André, Wietschel Martin. 2015. Modelling market diffusion of electric vehicles with real world driving data – German Market and policy options. *Transport research. Part 1, Policy and practice* ***77***: 95-112.

Graham-Rowe Ella, Gardner Benjamin, Abraham Charles, Skippon Stephen, Dittmar Helga, Hutchins Rebecca, Stannard Jenny. 2012. Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations. *Transportation Research. Part A, Policy and Practice* ***46***: 140-153.

Guo Zhaomiao, Deride Julio, Fan Yueyue. 2016. Infrastructure planning for fast charging stations in a competitive market. *Transportation Research Part C: Emerging Technologies* ***68***: 215-227.

Hagman Jens, Ritzén Sofia, Janhager Stier Jenny, Susilo Yusak. 2016. Total cost of ownership and its potential implications for battery electric vehicle diffusion. *Research in Transportation Business And Management* ***18***: 11-17.

Hanley Steve. 2018. 1000 Electric Buses to Spearhead Paris Goal of 100% Zero Emission Public Transportaiton. *Clean Technica* 23 April: Https://cleantechnica.com/2018/04/23/1000-electric-buses-to-spearhead-paris-goal-of-100-zero-emissions-public-transportation/

Harris Mark. 2017. Electric cars may stall without a battery revolution. *The Guardian* 19 July*:* https://www.theguardian.com/sustainable-business/2017/jul/19/electric-cars-battery-revolution-tesla-volvo

Hertzke Patrick, Muller Nicolai, Schenk Stephanie. 2017. Dynamics in the global electric vehicle market. M*cKinsey And Company*: 1-8.

Holtsmark Bjart, Skonhoft Anders. 2014. The Norwegian support and subsidy policy of electric cars. Should it be adopted by other countries? *Environmental Science And Policy* ***42***: 160-168.

Hooftman Niels, Oliveira Luis, Messagie Maarten, Coosemans Thierry and Van Mierlo Joeri. 2016. Environmental Analysis of Petrol, Diesel and Electric Passenger Cars in a Belgian Urban Setting. *Energy* ***9***. 1-84.

Kenton Will. 2018. Business Ecosystem. *Investopedia* 23 January: https://www.investopedia.com/terms/b/business-ecosystem.asp

Kihm Alexander, Trommer Stefan. 2014. The new car market for electric vehicles and the potential for fuel substitution. *Energy Policy* ***73***: 147-157.

Klechtermans Stijn. 2018. Class of innovation and value chain management. University of Hasselt.

Kley Fabian, Lerch Christian, Dallinger David. 2011. New business models for electric cars – a holistic approach. *Energy Policy* ***39***: 3392-3403.

Klöckner Christian Andreas, Nayum Alim, Mehmetoglu Mehmet. 2013. Positive and negative spillover effects from electric car purchase to car use. *Transportation research. Part D, Transport and environment* ***21***: 32-38.

Knufer Stefan M., Hensley Russell, Hertzke Patrick, Schaufuss Patrick. 2017. Electrifying insights: how automakers can drive electrified vehicle sales and profitability. *McKinsey and Company*: 1-26.

Knufer Stefan M., Noffsinger Jesse, Sahdev Shivika. 2018. How battery storage can help charge the electric-vehicle market. *McKinsey and Company*: https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/how-battery-storage-can-help-charge-the-electric-vehicle-market

KU Leuven. 2018. Scientists reveal the hidden costs of cobalt mining in DR Congo. *NewsRX Health.*

Leviakangas Pekka, Kinnunen Tuomo, Kess Pekka. 2014. *The electric vehicles ecosystem model: Construct, Analysis and Identification of Key challenges.*

Levien Roy, Lansiti Marco. 2004. *The Keystone advantage.* Harvard Business School: Boston.

Lu Lu. 2018. How Did Shenzhen, China Build World's Largest Electric Bus Fleet? *World Resources Institute* 4 April: https:// www.wri.org/blog/2018/04/how-did-shenzhen-china-build-world-s-largest-electric-bus-fleet

Malling Nicolai, Heilig Micheal, Weiss Christine, Chlond Bastian, Vortisch Peter. 2015. Modelling the weekly Electricity Demand Caused by Electric cars. *Future Generation Computer Systems* ***64***: 140-150.

McDonald Loren. 2018. Stop comparing the number of gas stations to EV charging stations. *Clean Technica* 7 March: *https://cleantechnica.com/2018/03/07/stop-comparing-number-gas-stations-ev-charging-stations/*

McKinsey & Company. 2013. The road to 2020 and beyond: What's driving the global automotive industry? *McKinsey and Company*: 1-24.

Mohr Detlev, Kaas Hans-Werner, Gao Pauk, Wee Dominik, Möller Timo. 2016. Automotive revolution – perspective towards 2030. *McKinsey and Company*: 1-20.

Moore James F. 1993. *Predators and Prey: A new ecology of competition.* Harvard Business Review: United States.

Nanaki Evanthia A., Koroneos Christopher J. 2013. Comparative economic and environmental analysis of conventional, hybrid and electric vehicles – the case study of Greece. *Journal of Cleaner Production* ***53***: 261-266.

Nealer Rachel. 2015. Gasoline vs Electric—Who Wins on Lifetime Global Warming Emissions? We Found Out*. Union of concerned scientists* 12 November: https://blog.ucsusa.org/rachael-nealer/gasoline-vs-electric-global-warming-emissions-953

Okoro Emma. Business ecosystem*. Provenmodels.* https://www.provenmodels.com/574/business-ecosystem/moore,-james-f

Pasaoglu G., Fiorello D., Martino A., Zani L., Zubaryeva A., Thiel C. 2013. Travel patterns and the potential use of electric cars – Results from a direct survey in six European countries. *Technological Forecasting and Social Change* ***87***: 51-59.

Poon Linda. 2018. How China Took Charge of the Electric Bus Revolution. *City Lab* 8 May: https://www.citylab.com/transportation/2018/05/how-china-charged-into-the-electric-bus-revolution/559571/

Propfe Bernd, Kreyenberg Danny, Wind Joerg, Schmid Stephan. 2013. Market penetration analysis of electric vehicles in the German passenger can market towards 2030. *International Journal of Hydrogen Energy* ***38***: 5201-5208.

PTI. 2017. Government Eyes 100% Electric Public Transport Through FAME 2. *Car And Bike* 28 December: https://auto.ndtv.com/news/government-eyes-100-electric-public-transport-through-fame-ii-1792951

Radosavljevic Zoran. 2017. Study: Poor marketing and choice of electric vehicles undermines Europe sales. *Euractiv* 6 September: https://www.euractiv.com/section/electric-cars/news/study-poor-marketing-and-choice-of-electric-vehicles-undermines-their-sale-in-europe/

RTL INFO. 2018. Des véhicules électriques chinois bientôt assemblés dans l'ancienne usine Caterpillar de Gosselies? *RTL Info* 5 May: https://www.rtl.be/info/regions/hainaut/des-vehicules-electriques-chinois-bientot-assembles-dans-l-ancienne-usine-caterpillar-de-gosselies--1019241.aspx

Sanderson Henry. 2017. Rise of electric cars poses battery recycling challenge. *Financial Times* 3 September: https://www.ft.com/content/c489382e-6b06-11e7-bfeb-33fe0c5b7eaa

Schmidt Eric. 2017. Top 12 reasons why electric cars are better than gas cars. *Fleet Carma* 6 September: https://www.fleetcarma.com/why-electric-cars-are-better-than-gas-top/

Silvia Chris, M. Krause Rachel. 2016. Assessing the impact of policy interventions on the adoption of plug-in electric vehicles: An agent-based model. *Energy Policy* ***96***: 105-118.

Smitj Dave. 2015. The importance of building collaborative ecosystems. *Document Strategy* 18 Augustus: https://documentmedia.com/article-1969-The-Importance-of-Building-Collaborative-Ecosystems.html

The guardian. 2014. Tesla hands over the keys to its electric car technology. *The Guardian* 13 June: https://www.theguardian.com/environment/2014/jun/13/tesla-elon-musk-electric-cars-patent-technology

Van Der Put Roland. 2018. *How fast charging works*. *Olino Renewable Energy* 18 July: http://www.olino.org/us/articles/2016/07/18/22857

Verset Jean-Claude. 2016. La batterie: le côté obscure de la voiture électrique. *RTBF* 27 April: https://www.rtbf.be/info/societe/detail_la-batterie-le-cote-obscure-de-la-voiture-electrique?id=9280221

Vinicius Xavier Dias Marcos, Haddad Jamil, Nogueira Luiz Horta, Da Costa Bortoni Edson, Passos da Cruz Ricardo Alexandre, Yamachita Roberto Akira, Goncalves Jose Luiz. 2013. The impact of electricity demand and emissions due to the introduction of electric cars in the Sao Paulo Power System. *Energy Policy* ***65***: 298-304.

Wolf Ingo, Schröder Tobias, Neumaan Jochen, De Haan Gerhard. 2015. Changing minds about electric cars: An empirically grounded agent-based modelling approach. *Technological Forecasting and Social Change* ***94***: 269-285.

World Economic Forum. 2017. Batteries can be part of the fight against climate change — if we do these five things. *Medium* 29 November: https://medium.com/world-economic-forum/batteries-can-be-part-of-the-fight-against-climate-change-if-we-do-these-five-things-6f1bb8c674d8

Wu Geng, Inderbitzin Alessandro, Bening Catharine. 2015. Total cost of ownership of electric vehicles compared to conventional vehicles: A probabilistic analysis and projection across market segments. *Energy Policy* ***80***: 196-214.

Yoney Domenick. 2018. 7 electric cars with the biggest batteries. *Inside EVs* 2 June: https://insideevs.com/seven-electric-cars-biggest-batteries/

Zenginis Ioannis, S. Vardakas John, Zorba Nizar, V. Verikoukis Christos. 2016. Analysis and quality of service evaluation of a fast charging station for electric vehicles. *Energy **112***: 669-678.

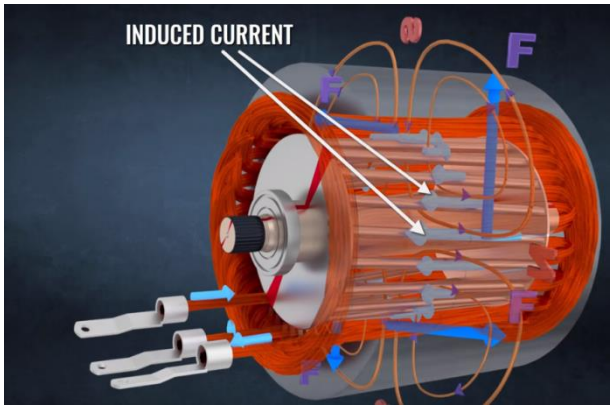
Zsuzsa Lévay Petra, Drossinos Yannis, Thiel Christian. 2017. The effect of fiscal incentives on market penetration of electric vehicles: A pairwise comparison of total cost of ownership. *Energy Policy **105***: 524-533.

Appendices

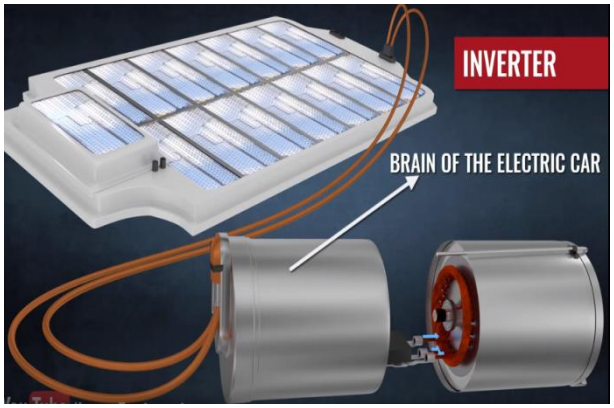
Appendix 1

Images from the video “How does an electric car work?”

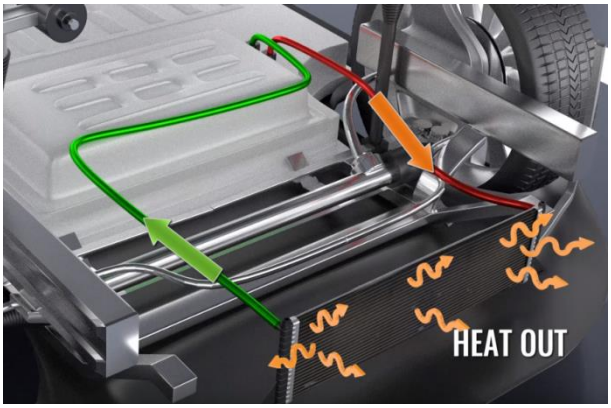
General motor overview



Rotating magnetic field

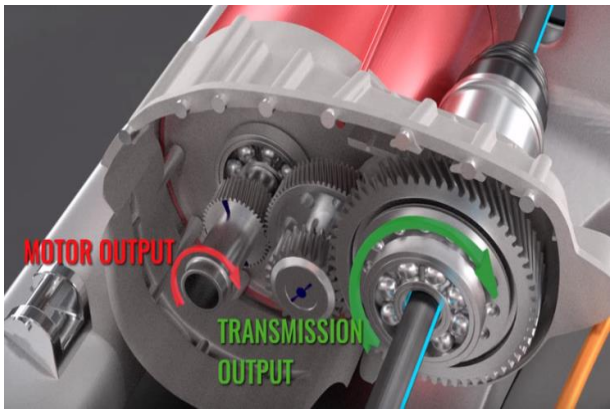


Batteries to inverter to alternative current



Cooling down of glycol coolant

From the single transmission to wheels



Within the single transmission

Appendix 2

Interview Galand Benoît

1) May I ask you to introduce your business and your role within this business?

I am journalist for 30 years in the automobile industry. In the past, I was director of my own magazine called “Turbo Magazine”. Currently, I am an independent journalist.

2) Where do you think we are actually going? What will the market look like in 10 / 20 years?

In my opinion, the final solution is not dependent only on one technology. It will be a mix of multiple technologies as the electric, hydrogen, gasoline and biomass technologies. Each road user will have to make a conscious choice in line with his own needs.

Even if it may be difficult concerning the infrastructure, it is not possible for the world to accept only one technology. Each technology has advantages and disadvantages depending on the needs. There is no one best choice.

3) What is your opinion about the electric car?

For urban moves, I totally trust the electric car. I have the same opinion concerning the public transport. However, there are still some domain I do not trust the electric car. For example: long trips as to go on holiday. I am also not convinced about powerful electric cars as Tesla. If you want to use the power of your Tesla, the autonomy goes sharply down. It is not interesting at the end.

4) How green do you see an electric car?

Globally, I think it is not as green as authorities said. There is a big problem about the origin of the car components. In addition, the treatment and recycling of the various waste is not developed. Moreover, the electricity generation is not green at all. Clearly, we are not ready to switch to the electric car.

5) What are the main advantages of the electric car?

Firstly, some UE agreements over the ecology force manufacturers to invest in the electric car. The second advantage is its ease of use. The motor is very simple to understand and the car is easy to drive.

6) Do you have a reason to explain why nobody is buying electric cars at the moment?

First of all the price, it is a huge investment. Secondly, the autonomy and the infrastructure.

7) What do you think electric cars have to change to be more attractive for consumers?

Price has to decrease for sure. It is only possible if the electric car achieve bigger scales of production. After that, the batteries should offer an extended autonomy. However, technology progress faster than we all think. We are always surprised. It may be resolve in a near future.

8) How to transform old competitors into partners?

In my opinion, it is totally impossible. There are too many economic interests. Everybody want to win out of the electric car introduction, they are not going to collaborate. It is too dangerous for their personal profits.

9) According to you, who will win out the creation of electric cars?

Without any hesitation, the electricity producers and the battery producers will be the big winners of this new wave. They are dominating the game. Everything depends on them and their willingness to push the technology further.

10) Do you think manufacturers are really interested in the electric technology of they are just investing to respect the different UE agreements?

Honestly, I think they are just interested in their green image. They are also obligated to respect some emissions quotas for 2020. If one day, they are truly decided to switch to the electric car, competition will be back and the technology will progress at an impressive speed.

11) In your opinion, what is the role of the government in the construction of the electric car ecosystem?

I think the government should not be focus only on the electric car. It means incentives should depend on how the car is used. As I said before, the electric car is not always the best solution concerning some needs. Therefore, I think their incentives should not be focused only on the electric car. Incentives should reward people making the optimal choice in line with their use of the car.

However I still don't understand why the public transport is currently not electric. Even if it is expensive, it is easy to implement. For example the buses have many places to install batteries. Moreover, we know exactly how many kilometers they travel on a day. It may show the good example to the population.

Interview Miserque Thibaut

1) May I ask you to introduce your business and your role within this business?

I am working in the sales department of Tesla in Belgium. My function is product specialist. Basically I do everything for the customer experience: from checking the coffee machine to delivering the car to the customers. Tesla is a California based brand. In Belgium, we depend directly from Tesla. It is not like every other manufacturers that have independent garages. All our Tesla shops are owned directly by Tesla.

Besides that I also do a bit of car journalism so I have some knowledge of the market today.

2) Where do you think we are actually going? What will the automotive industry look like in 10 or 20 years in your opinion?

I believe we are going to a mix of technologies according to what suits best the need of the driver and circumstances. Someone who drives 10km every day in the city and 2 times a year goes on holiday has no need to drive an Internal Combustion Engine. He can choose an EV. Someone who needs to drive very long distances will choose an ICE (internal combustion engine).

3) Do you think electric cars have a future in this world? Why?

Yes, mainly for urban areas. It is silent, it is smooth and quick. It does not require an important autonomy. Moreover it is a nice solution against the city pollution. However, one thing that needs to be better is the fast charging stations and the battery autonomy.

4) How green do you see an electric car?

Very depending on the electricity used to charge. To be green, electric cars should only be charged with energy produced by renewable sources. The best example would be charging at home using the electricity produced by your solar panels. But then you still have to take into account all the energy needed to produce the solar panels… In addition to this, batteries are needed to store the energy coming from the solar panels.

5) What are the main advantages of the electric car?

Comfort! It is so comfortable to drive and relaxing. The silence and the smoothness are incredible. I personally do not want anything else than an EV for my city moves.

6) Do you have a reason to explain why nobody is buying electric cars at the moment?

First of all, I will say the price. Even if the high prices of petrol and diesel nowadays are playing in favour of the electric technology (we see more and more people coming to buy a Tesla). The people interested are mainly business owners of independent workers. Nevertheless a large part of the population does not have the money to buy a Tesla.

The other element is called “Range anxiety”. People are afraid of running out of power. In every conversation with a new customer, this topic comes out.

7) What do you think electric cars have to change to be more attractive for consumers?

A wider and denser network of fast charging stations. If you look on the map of Tesla’s own Superchargers in Wallonia, we only have three: Nivelles, Arlon & Verviers. It is not attractive at all. It has to be improved.

Another point to be improved is the charging possibilities for people living in urban areas who not have access to a garage or a parking spot. Where can they charge their car? A solution should be proposed for those people. As said before, the electric car is perfect for urban moves. But it is still difficult to charge an EV for people living in those urban areas. It has to be upgraded also.

8) According to you, who will win out the creation of electric cars?

The winner will be the one controlling most of the electricity network and charging station network. The company that is going to find a solution for city charging in shared buildings/areas will also win a lot.

9) Do you think that more than 30% of sold cars may be electric in 2030? Why?

At the rate our customer basis is growing, and since the other manufacturers are developing their EV range faster, it should be possible. 10 years is a very very very long period for the car industry. In addition, the development of batteries goes very fast, it is improving every day.

10) How is it possible to stimulate collaboration between long-term competitors in order to leverage the whole market?

Sharing fast charging network infrastructures might be a thing. At one point it will be unavoidable. It would be a nice first step to improve collaboration between competitors to leverage the whole market. However, I am not sure a true and long-term collaboration is possible.

11) In your opinion, what is the role of the government in the construction of the electric car ecosystem?

In my personal opinion its role should only be to facilitate the purchase of electric cars. The high fuel prices for petrol cars and low road taxes for electric vehicles should act as a boost for the electric market. Nevertheless, we need long-term laws and agreements if we want people to trust and to invest in a new technology. The government changes its opinion and laws too often.

12) How can connectivity in a car bring a plus point for the whole ecosystem?

Further than managing the charging via an app, it only brings an increased comfort. The automotive industry is running for years without such connectivity. But as we know comfort is an important criterion for our customers. Clearly, the advantage for the ecosystem is to manage the charging behaviour of electric car users.

13) In your opinion, what is the main difference in the value proposition between electric cars and gasoline cars?

The proposed comfort is different. For EVs, we talk about noise and driving comfort. For ICE cars, the comfort is more in line with the developed infrastructure and the large choice of vehicles available. The running costs are also reduced, at least divided by two for an electric car. In my opinion, the ecological factor is not that important in the value proposition.

14) Do you think it would be interesting for the government to electrify the public sector? Or is it too difficult to implement?

I would say it is more than interesting. It is needed in cities. Replacing old diesel buses by electric buses that are silent and do not smoke the cyclists and pedestrians would be needed to improve the quality of life in city centers. Even if it cost a lot of money to do it right, everybody would benefit from it.

It is also important to think that more buses will be needed. A rotation between buses running in the city while other buses are charging is needed.

15) In your opinion, what will be the biggest changes in the automotive industry due to the electric car?

Moving from private owned fuel stations (usable by every car) to manufacturers owned charging networks. Will a Mercedes ever be allowed to charge with a Tesla Supercharger?

16) Concerning Tesla and the fact than they open their IP freely to other competitors to boost the whole market. What do you think about it?

The mission of Tesla is to accelerate the transition to renewable energy, so it is not a problem. If one day the company should go bankrupt (for real), other manufacturers will always fight to buy them in order to access their technology. By technology I mean big assembly lines, battery manufacturers etc.

17) Do you think Tesla can be profitable in the long term?

Yes. There are many opportunities for Tesla in the future. They can continue to develop the technology themselves or they can form partnerships with other brands. They just have to choose the most profitable solution.

18) Do you think Tesla can be competitive against the other large manufacturers when they are going to increase their involvement in the electrification phenomenon?

Other manufacturers have more experience in building cars than Tesla has. For sure it will be difficult. But Tesla has much more experience in the electric technology. For some points (as comfort, luxury equipment and reliability), Tesla does not possess the same knowledge and capabilities than big manufacturers. However, they are already a step further concerning the technical part of the electric vehicle.

Interview Neve Laurence

1) May I ask you to introduce your business and your role within this business?

Kyburz has been created 27 years ago. We have always been working in the electric technology. Our main product is the tricycle. For example, we have sold 7000 tricycles to the post in Switzerland.

Personally, I am responsible of the eRod department (eRod is our sport electric vehicle). From communication to marketing or sales, we perform all the tasks.

2) Where do you think we are actually going? What will the market look like in 20 years?

I think in 20 years, the market will be much bigger. Currently, some manufacturers are invested in the electric technology. As soon as the customers will easily charge his car, the market will explode. Everything depends on it.

3) How green do you see an electric car?

The perfect solution would be that everybody produces his own electricity himself. It is also the case for the various factories producing electric cars. Thanks to solar panels, wind turbines or other solutions, everything in line with the electric car should be green. This would be perfect for the whole ecosystem.

4) What are the main advantages of the electric car?

For cities, it is the perfect tool. The electric car diffuses zero emission while moving. It is also silent what makes it more adapted for urban users.

However, I think we cannot have only one technology on our roads, it should be a mix. There are many possibilities: hydrogen, gasoline, diesel, electric. By the way, I am a strong believer that we must continue to improve our gasoline cars. The entire world would benefit from it.

5) What will be the biggest obstacle for electric cars introduction? What do you think electric cars have to change to be more attractive for consumers?

Obviously, we need a strong recycling system. What are we going to do with the used batteries? Do we stock it? Do we recycle it? Everybody is doubtful about this point. We have to work on it!

6) According to you, who will win out the creation of electric cars? Who will lose from the introduction of electric cars?

Concerning manufacturers, I do not think there will have winners or losers. However, each manufacturer has to include electric vehicles in its range.

It is sure that gasoline providers will lose from the electric car introduction. Concerning the service stations, they have to adapt themselves with electric charging points if they do not want to lose from this new wave.

7) How is it possible to stimulate collaboration between long-term competitors in order to leverage the whole market?

Honestly, for me it is totally needed. All the manufacturers and charger providers have to collaborate to propose a common system. I think they are smart enough to realize it and to start collaborating in a near future. Without such collaboration, we will not have common basis for the electric car. It will become a powerful obstacle.

8) In your opinion, what is the role of the government in the construction of the electric car ecosystem?

In my opinion, they have to focus on the charging points. They have to install charging points in each city, each parking. In addition they have to work on the background to make the energy provenance as clean as possible.

9) Does the government help your business in Switzerland (monetary or non-monetary)?

Concerning our business, I have no idea about it. However, I know there is no monetary incentives for electric car buyers in Switzerland.

10) What kind of new revenues can generate the introduction of electric cars?

New opportunities for battery producers and charging point providers are emerging. But it has to be more developed in Europe. Currently, everything comes from China.

Moreover, renewable energy producers can benefit from it. As everybody want green energy to aliment their electric car, I am sure this market will grow. For example: solar panel producers.

Finally, people working on the technical part of the electric technology will benefit from this new wave. Their skills and capabilities are crucial for the ecosystem running.

11) Do you think electric cars will be the last wave in the car industry?

Clearly it will evolve again. I hope it is not the last wave. I hope other sources of energy will be found in the future. I hope the automotive industry will keep on working on green energy sources. I do not think it is the last wave. The automotive industry is continuously evolving.